Province of British Columbia
Ministry of Environment
ASSESSMENT AND PLANNING DIVISION

AQUATIC INVENTORY OF THE UPPER TURNAGAIN RIVER AREA 1980

WORKING REPORT

by

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ABSTRACT

A biophysical aquatic inventory was conducted during the summer of 1980 on upper portions of the Turnagain, Eagle, and Tanzilla River watersheds in north-central British Columbia. The purpose of the survey was to gather fisheries data on which to base management decisions in mitigating impending resource development in the area.

The report summarizes survey results and includes an outline of physical stream features, fish distribution, age and growth data, stream fish habitat, and sport fish values. Present habitat protection problems and potential impacts of ESSO Minerals Canada's proposed Kutcho Creek mine development are discussed.

Rainbow trout (Salmo gairdneri), lake trout (Salvelinus namaycush), Dolly Varden (Salvelinus malma), Arctic grayling (Thymallus arcticus), and mountian whitefish (Prosopium williamsoni) are the major sport fish species in the area. Sport fish values appear to be mainly concentrated in lakes and portions of the larger rivers. The report includes habitat descriptions and evaluations for each reach surveyed.

Preliminary age analysis of fish from one lake in the study area indicates that growth rates are relatively slow and that rainbow trout and mountain whitefish reach sexual maturity at a relatively late age.

Present habitat protection problems include sedimentation from placer mining operations and from poor-quality winter roads.

The most important potential impacts of mineral development are possible water contamination from mine wastes and increased exploitation of fisheries resources due to improved access.

PREFACE

This report is intended to provide an interpretive summary of the survey data and to elaborate on specific material requested by the agency initiating the survey (Region 7, B.C. Fish and Wildlife Branch).

Data collected are summarized on 1:50 000 Aquatics Biophysical Maps and are stored in a computerized data base. The maps act as an index to available data, serve as location references for channel features (such as sampling locations, waterfalls, etc.), and summarize much of the most commonly sought information. Computer printouts present a complete data record of ground sampling locations and reach characteristics.

Maps and computer printouts are available by contacting; Aquatic Studies Branch, B.C. Ministry of Environment, Parliament Buildings, Victoria, B.C. V8V 1X5.

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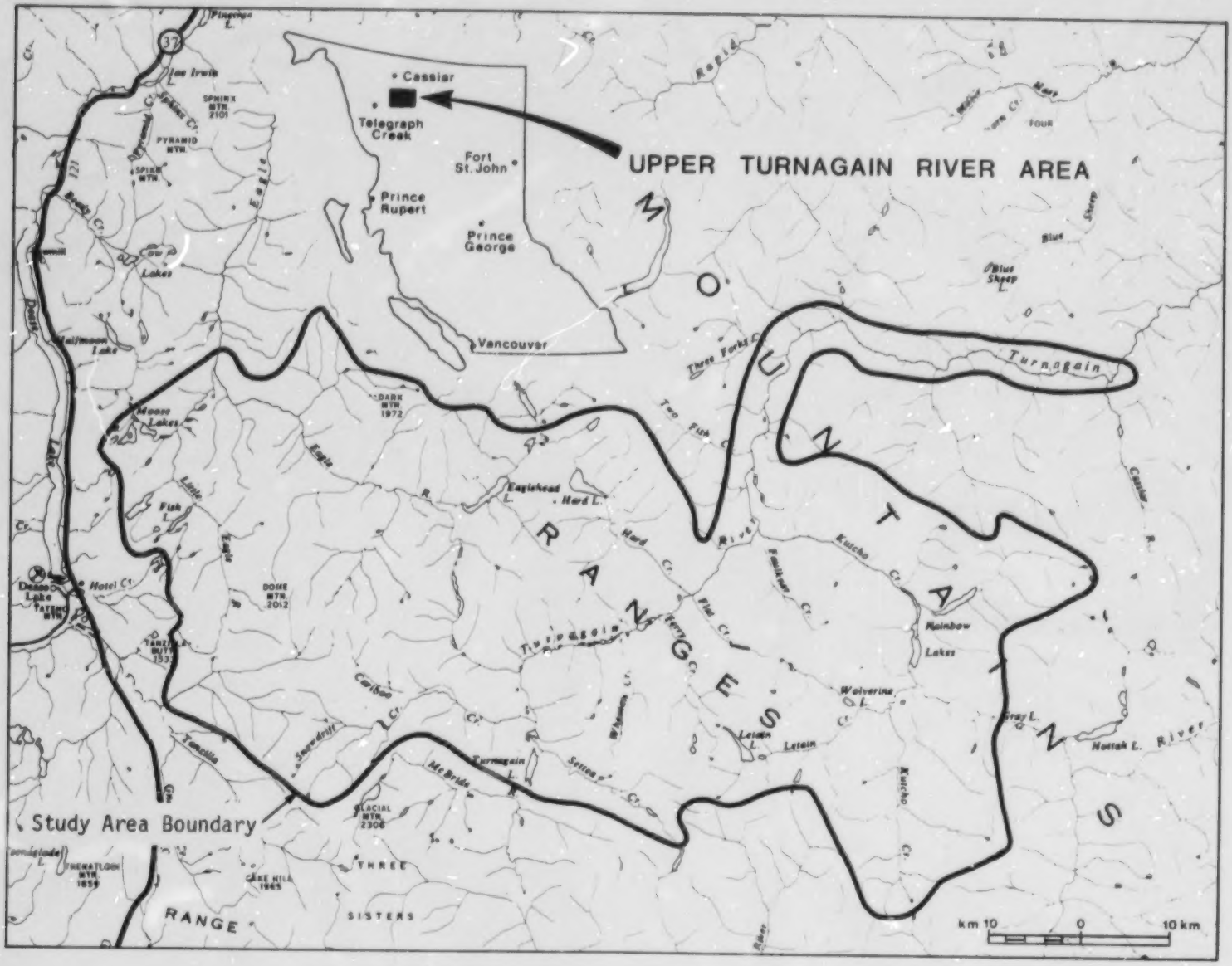

FIGURE 1 KEY MAP OF UPPER TURNAGAIN RIVER STUDY AREA

1.0 INTRODUCTION

1.1 Study Area

The study area consisted of the upper portions of the Turnagain and Eagle River watersheds, plus the Zuback Creek drainage, a tributary of the Tanzilla River (see Figure 1). This area lies directly east of the community of Dease Lake in the Stikine Ranges of north-central British Columbia.

The upper Turnagain and Eagle systems are Arctic drainages which lie to the west of the main part of the continental divide, formed in this region by the Cassiar batholith (Geological Survey of Canada, 1957). Both of these rivers cut through the Cassiar Mountains and enter the Liard River system - the Eagle River via the Dease system, and the Turnagain River via the Kechika. Zuback Creek and the Tanzilla River are part of the Pacific drainage and flow westward to enter the Stikine.

The general topography of the region consists of sharply glaciated peaks and ridges (over 1800 m), with U-shaped valleys containing tills and glaciofluvial deposits. In many areas (such as Snowdrift Creek, upper Hard Creek, and parts of the Eagle River), valleys have been filled with morainal and outwash deposits, forming broad, shallow basins (Geological Survey of Canada, 1957). Ice contact features such as eskers, kames and kame terraces are common throughout the area. The highest point in the study area is King Mountain (2408 m), while the lowest elevation is approximately 760 m, on the Turnagain River at the downstream limit of the survey.

The uplands in the region lie in the Arctic Tundra biogeoclimatic zone, while the middle and lower slopes are in the Spruce-Willow-Birch zone (subalpine Alpine Fir zone (Terrestrial Studies Branch, 1982)). The lowest elevation valley bottoms are in the Boreal White and the Black Spruce zone (Krajina, 1965).

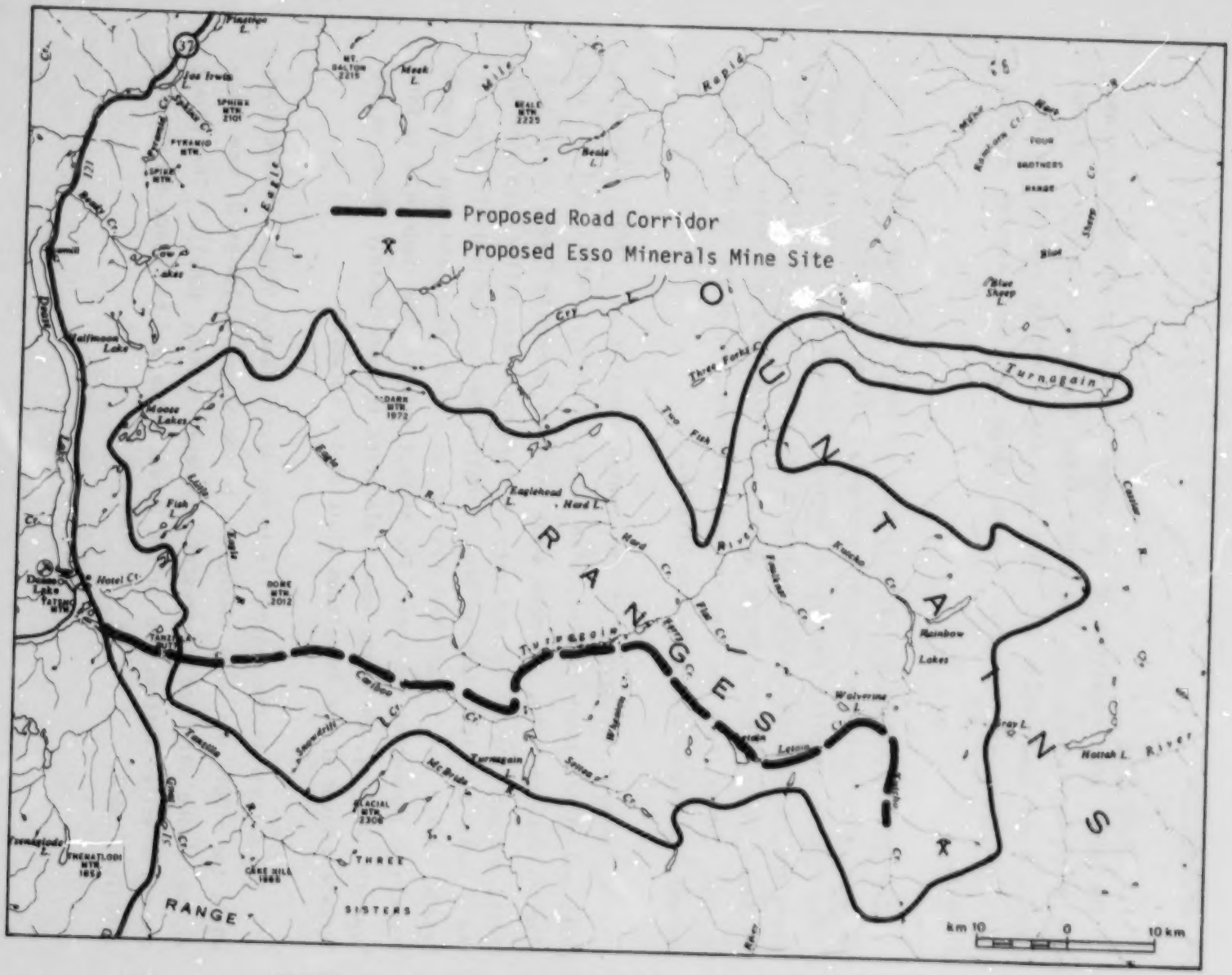

FIGURE 2 LOCATION OF CORRIDOR FOR PROPOSED ACCESS ROAD

Precipitation in the region is light, with the highest values occurring during the summer months (see Appendix 3). Slightly less than half the yearly total falls as snow.

The usual access to the area is by air from Dease Lake. There are airstrips at Kutcho Creek, Letain Creek, Hard Lake and Hard Creek, and float plane access is possible on all the larger lakes. A system of tractor roads also exists, connecting mining operations at Wheaton Creek and Kutcho Creek with the Stewart-Cassiar Highway. The road system is generally passable only in winter. Travel by foot or on horseback is also quite feasible, as much of the area is open, alpine country.

Current economic activity in the study area is centered around mineral exploration, placer gold mining and jade extraction. Placer mining activity is occurring along several streams, with major operations on Wheaton, Settea and Faulkner Creeks. The main jade extraction area is just west of upper Kutcho Creek. In addition, several other potentially valuable mineral deposits are known to occur in the area.

The population of the surrounding region is currently very sparse. Principal communities include Dease Lake (pop. 200), Telegraph Creek (pop. 300), and Cassiar (pop. 1500).

ESSO Minerals Canada has submitted a proposal to develop a large copper and zinc sulphide deposit located in a tributary valley, just east of upper Kutcho Creek. The development would include mine, mill and camp facilities. In conjunction with this proposal, there are plans to construct a 114 km access road which would generally follow the route of the existing winter tractor road (see Figure 2). This all-weather road would be used to haul ore from the mine site and would also provide access to other mineral resources in the area.

1.2 Objectives

The objective of the survey was to obtain biophysical stream and lake information on which to base management decisions in mitigating impending

developments in the area. The survey was intended to determine sport fish distribution, to describe fish habitats, and to assess the impacts on the fisheries resource of development and increased access within the study area.

1.3 Methods

The stream survey work was conducted using Aquatic Studies Branch stream inventory methodology (Chamberlin, 1980). Preliminary reach typing of watersheds was done from air photographs. A fixed-wing reconnaissance flight of the study area was flown on June 24, 1980, to determine reach breaks and identify major features.

Field sampling and final stream typing was done between July 22 and July 28, 1980, using helicopter access. Biophysical stream data were recorded on Resource Analysis Branch data cards (1980 version). Fish sampling was carried out using Smith-Root Type VIII and Type VIIIA electrofishers, Gee minnow traps, and by angling. Photographs were taken to augment the field data.

Lake sampling was also conducted on 15 lakes in the study area between July 23, and August 11, 1980. Complete lake surveys (including bathymetric mapping) were done on 5 lakes (North and South Rainbow, Letain, Wolverine and "Elephant" Lakes). Fish sampling and basic water chemistry measurements were completed on the other 10 lakes (Provencher, Settea, Turnagain, "Three Kettle", Hard, Eaglehead, "Serpentine", Moose, Swinton and Fish Lakes). The results of these lake surveys are summarized, in symbol form, on the Biophysical Aquatic Maps. Complete lake survey reports are available from the Aquatic Studies Branch, Parliament Buildings, Victoria, B.C. V8V 1X5.

1.4 Sampling Difficulty

It should be noted that all field work was done during a period of high streamflows following heavy summer rains. High water levels and turbidity hampered the assessment of some physical stream parameters and made fish sampling very difficult.

2.0 SUMMARY OF RESULTS

2.1 Physical Features

2.1.1 Turnagain River System

The Turnagain River cuts through the main part of the Cassiar Mountains in the northeastern portion of the study area (downstream from Kutcho Creek). This section of the river (Reaches 101, 102, 103 and 104) is confined to a fairly narrow, U-shaped valley and has several bedrock constrictions (see Plate #1). An impassable (15 m) falls and canyon section is located in Reach 102, approximately 1 km upstream from the Cassiar River at the lower end of the study area (see Plate #2). The upper reaches of the Turnagain (Reaches 105-116) are broader, less confined, and have many ice-contact features in the valley bottom (see Plate #3).

Almost all tributaries to the upper Turnagain River have impassable falls or steep gradient sections near their mouths. There is speculation that the Turnagain Valley may have been uplifted at one time, causing down-cutting by the river, and forming hanging valleys in most tributaries (Geological Survey of Canada, 1957). The only streams without major obstructions in their lower reaches are Settea, Hard, and Kutcho Creeks.

Kutcho Creek is the largest tributary to the upper Turnagain. Reaches 1 and 2 of Kutcho Creek are confined, with a high percentage of bedrock banks (see Plate #4). The upper reaches are less confined, lower gradient, and have morainal or glaciofluvial materials in the valley bottom (see Plate #5).

Plate #1 (Left)

Typical view of Reach 103, Turnagain River.

Plate #2 (Below).

Impassable 15 m falls on the Turnagain River near the Cassiar River Confluence.

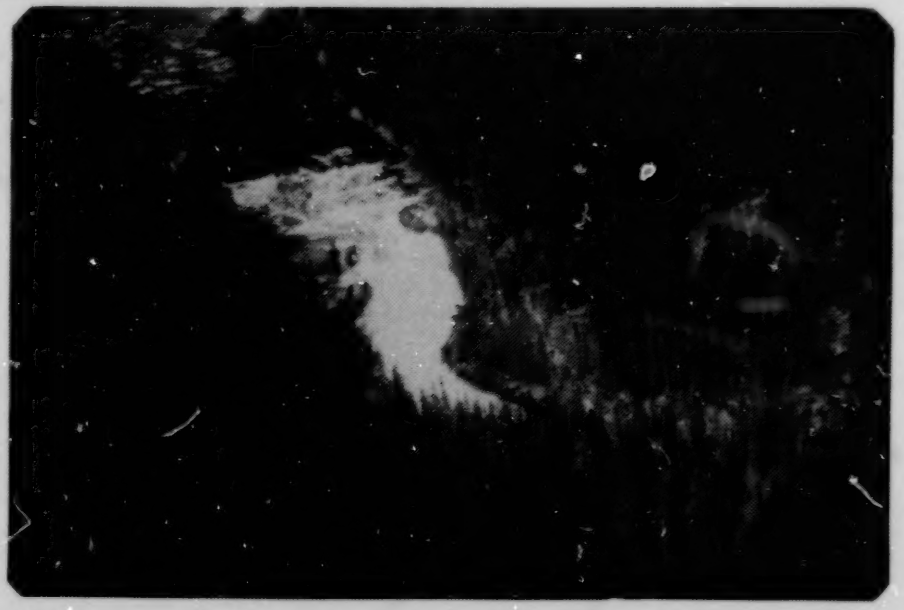

Plate #3. Upper Turnagain River (Reaches 106-108) showing lack of confinement and the many ice contact features (Kettle Lakes, kames, eskers, etc.). (Photo by M. Fenger).

Plate #4. Kutcho Creek, Reach 2, showing confinement and bedrock substrate.

Plate #5. Kutcho Creek, Reach 7. Note lack of confinement and ice contact features.

Another important physical feature of the upper Turnagain system (with possible implications for fish distribution) is the very low and indistinct boundary between it and several adjacent watersheds. The most obvious example of this is between the Kutcho Creek and Tucho River watershed in the area of Gray Lake. The connecting valley is very low in this area, and it is possible that the watershed boundary could be shifted simply by beaver dam construction or very slight uplifting or subsidence of the land. Some other areas with low or indistinct watershed boundaries are the Letain Creek/Provencher Lake (Kehlechoa River system) area, the upper Snowdrift Creek/McBride River area, and the Hard Lake/upper Eagle River area. These areas may provide "transfer points" through which fish could gain access to adjacent watersheds.

2.1.2 Eagle River System

The upper Eagle River watershed has slightly more subdued relief than that of the Turnagain system. The mainstem Eagle River lies in a very broad, U-shaped valley (see Plate #6). Reaches 101 and 102 cut through some low hills and are slightly more confined than the upper portion. Although stream velocity is swift, there are no obstructions to fish passage below the headwater reaches.

The largest tributary in the system is the Little Eagle River. Reach 1 of the Little Eagle has low confinement, while the upper reaches lie in a narrow U-shaped valley (see Plate #7). This system also has no obvious obstructions below the headwater area.

2.1.3 Zuback Creek

Zuback Creek lies in a fairly broad, shallow basin (see Plate #8). There is an impassable falls and canyon area approximately 7 km upstream from the mouth (see Plate #9).

Plate #6. Eagle River, Reach 103. Typical broad valley and even gradient.

Plate #7. Typical upper reach of the Little Eagle River (Reach 3).

Photo #8 (Left).

Typical view of upper Zuback Cr. (above falls).

Plate #9.

Falls on Zuback Cr. approximately 7 km upstream from the mouth.

2.2 Fish Distribution

2.2.1 Limitations of Data

As stated in Section 1.4, fish sampling was very difficult due to high streamflows and turbidity. Relatively few individuals were captured while electrofishing and angling at stream sampling sites. Therefore, much of the information on fish distribution has been derived from the lake survey fish sampling data.

Other secondary sources of fish information were consultants' reports and anecdotal information from local guide-outfitters. Some detailed fish sampling has been done by consultants (R. Webb Env. Ser. Ltd., 1979 and Kristensen, 1980) in the immediate vicinity of the ESSO mine site on Andrea Creek and upper Kutcho Creek. However, no documented sampling has been done in the remainder of the study area.

Other factors which complicate the determination of fish distribution in this area include:-

1. The possibility of species transference from one system's headwaters to that of another, thereby creating anomalies;
2. The possibility of undocumented species introductions through stocking - i.e. there are unconfirmed reports that rainbow trout have been stocked in various locations by local guide-outfitters; and
3. The apparently transient nature of fish utilization, especially of smaller tributary streams - i.e. other studies in northern areas show that a species may utilize small streams only for very short periods of time and for very specific functions (such as spawning or fry rearing) (Butcher, 1981).

In the headwaters of several tributaries, we have inferred neither presence nor absence of fish species due to lack of fish sampling data and uncertainty as to whether fish passage is possible. In the lower reaches of some tributaries, we have inferred "fish species-general" (SP), to indicate that we feel at least some of the species from the mainstem likely utilize the reach.

Observed and inferred distributions of the five sport fish species within the study area are outlined in Figures #3 - #7.

2.2.2 Turnagain River System

Rainbow trout (Salmo gairdneri), lake trout (Salvelinus naymaycush), arctic grayling (Thymallus arcticus), mountain whitefish (Prosopium williamsoni), and longnose suckers (Catastomus catastomus) were captured during lake sampling of Turnagain Lake and another smaller kettle lake along the upper Turnagain River. In addition, Dolly Varden (Salvelinus malma)* and grayling were collected at point sample sites on the mainstem Turnagain River. All these species are inferred to be present throughout the mainstem, to the lower boundary of the study area. This inferrence is corroborated by local guide-outfitters who report that Dolly Varden, grayling, lake trout, mountain whitefish and rainbow trout are all present in the reach below the Turnagain Falls (J. Drift, personal comm.)[1].

It is assumed that rainbow trout were introduced, either naturally or by stocking (or a combination of the two), to the upper Turnagain/Kutcho system and have spread downstream from the headwaters. There is apparently no record of rainbow occurring further downstream in the Kechika system (Kristenen, 1980).

* Cavender (1978) has provided evidence to split S. malma into S. malma and S. confluentus. Both forms may be present in the Liard Drainage. We have retained the traditional nomenclature.

[1] John Drift, Turnagain River Guide, Williams Lake, B.C.

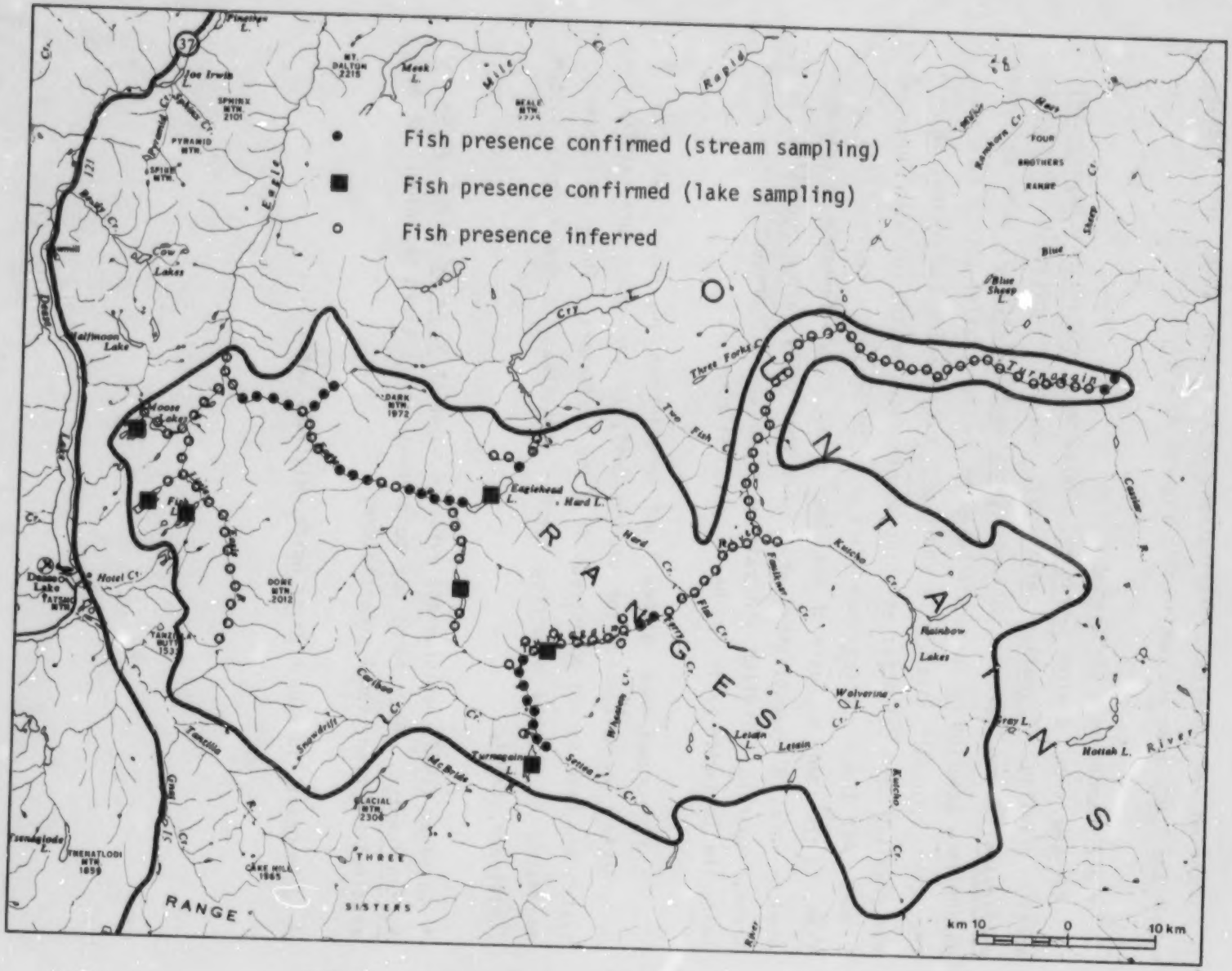
Fish presence confirmed (stream sampling)
Fish presence confirmed (lake sampling)
Fish presence inferred
LA NUTESS RANGE
THREE SISTERS RANGE
km 10 0 10 km

FIGURE 3 SPORTFISH DISTRIBUTION: ARCTIC GRAYLING

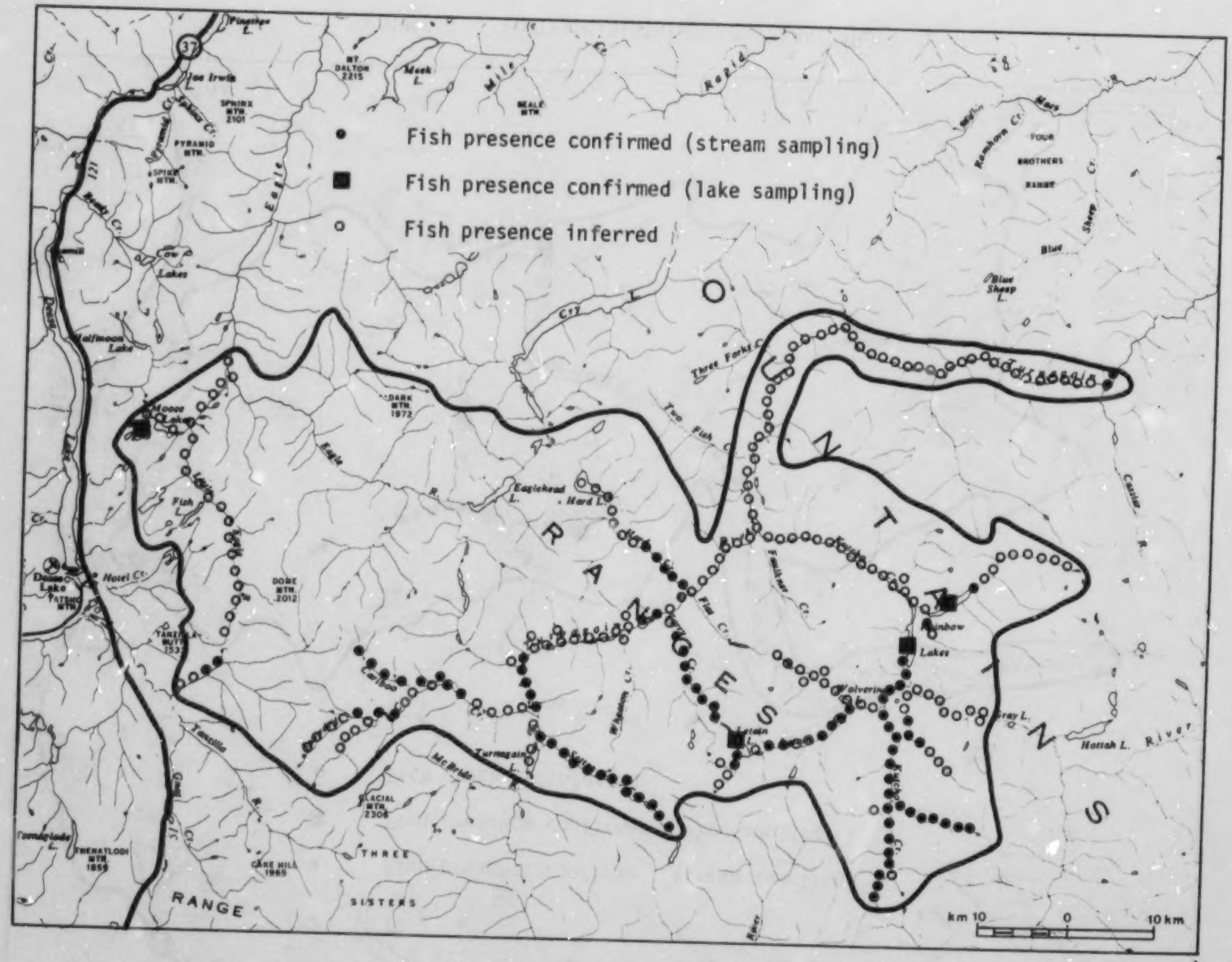

FIGURE 4 SPORTFISH DISTRIBUTION: DOLLY VARDEN

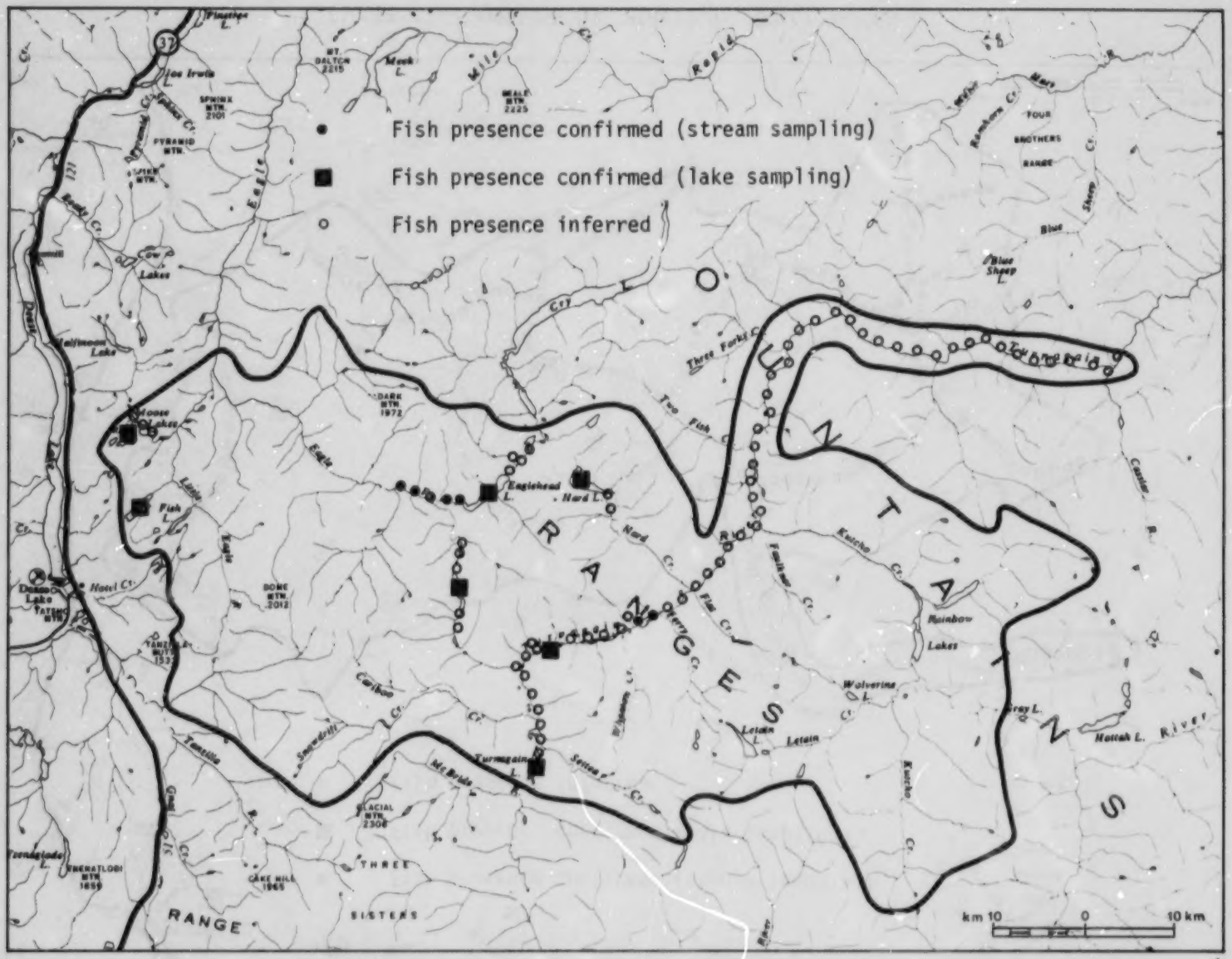

FIGURE 5 SPORTFISH DISTRIBUTION: LAKE TROUT

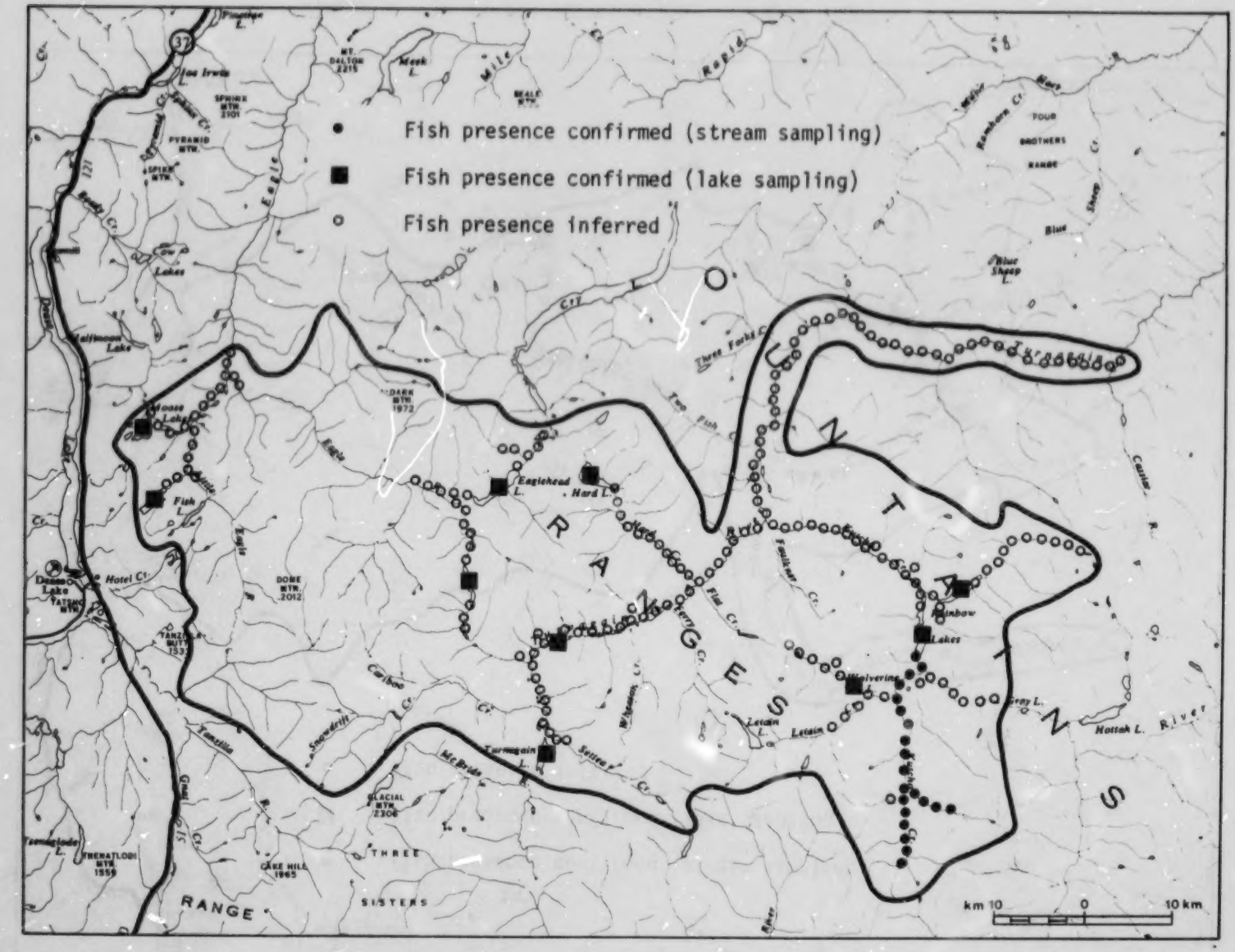

FIGURE 6 SPORTFISH DISTRIBUTION: MOUNTAIN WHITEFISH

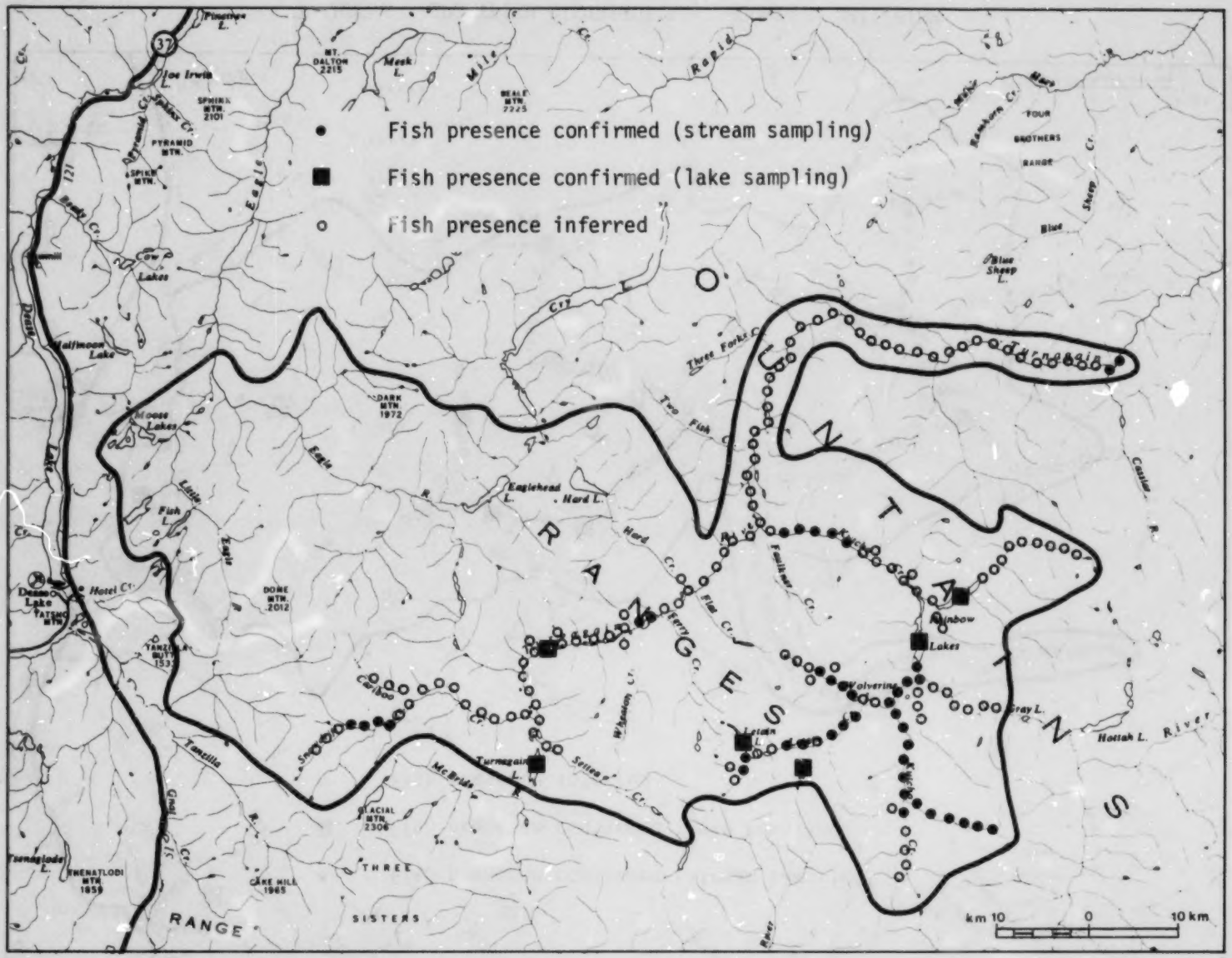

FIGURE 7 SPORTFISH DISTRIBUTION: RAINBOW TROUT

In Kutcho Creek, rainbow trout, Dolly Varden, and mountain whitefish occur throughout most of the system, and appear to be the only species present. Grayling, lake trout and suckers seem to be absent from the system entirely, perhaps as a result of the high velocity, bedrock sections in the lower two reaches of Kutcho Creek (see Plate #10).

Results of sampling and observations by consultants on Andrea Creek and upper Kutcho Creek seem to indicate that Dolly Varden occur farther upstream into the headwaters in this area than do rainbow trout (Kristensen, 1980). Both species were found above falls up to 4 m in height on Andrea Creek (see Plate #11). Mountain whitefish were captured only in the lower and middle reaches of these streams. There are also indications that a regular migration may occur into, and out of, the upper reaches from over-wintering areas in lower Kutcho Creek or the adjacent lakes (Kristensen, 1980).

Other tributaries to the upper Turnagain which contain fish populations are Hard Creek, Ferry Creek, Snowdrift/Cariboo Creeks and Settea Creek.

Lake trout, mountain whitefish, longnose suckers and probably Dolly Varden are present in Hard Lake and may occur throughout Hard Creek. It is possible, however, that some species (lake trout and suckers) may have gained access to this system via the headwaters, rather than from the mainstem Turnagain.

Dolly Varden were found above a major obstruction on Ferry Creek (see Plate #12), but again, access to this area may be possible through the headwaters from the Letain system.

Dolly Varden are present throughout the Snowdrift/Cariboo system and rainbow trout were captured in the upper reaches of Snowdrift Creek. This system has an impassable falls near its mouth (see Plate #13), but these species may have gained access to the system from upper McBride River, which shares the same broad basin in this area. It is also possible that rainbow have been stocked in the upper reaches.

Plate #10. Example of bedrock rapids section in lower Kutcho Creek (Reach 1). These rapids may block access to grayling, lake trout, and suckers.

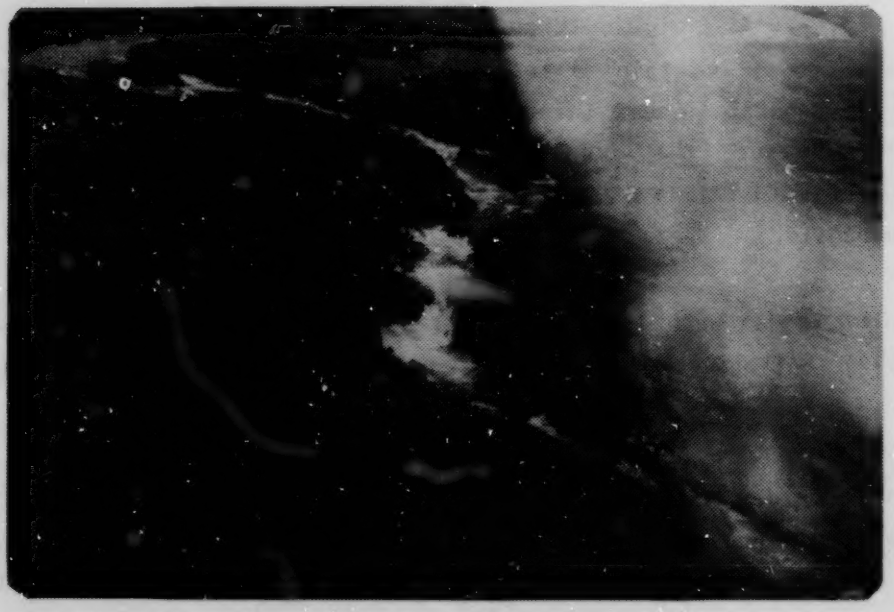

Plate #11. 4 m falls on Andrea Creek (Reach 4). Both Dolly Varden and rainbow trout were found upstream of this obstruction. (Kristensen, 1980).

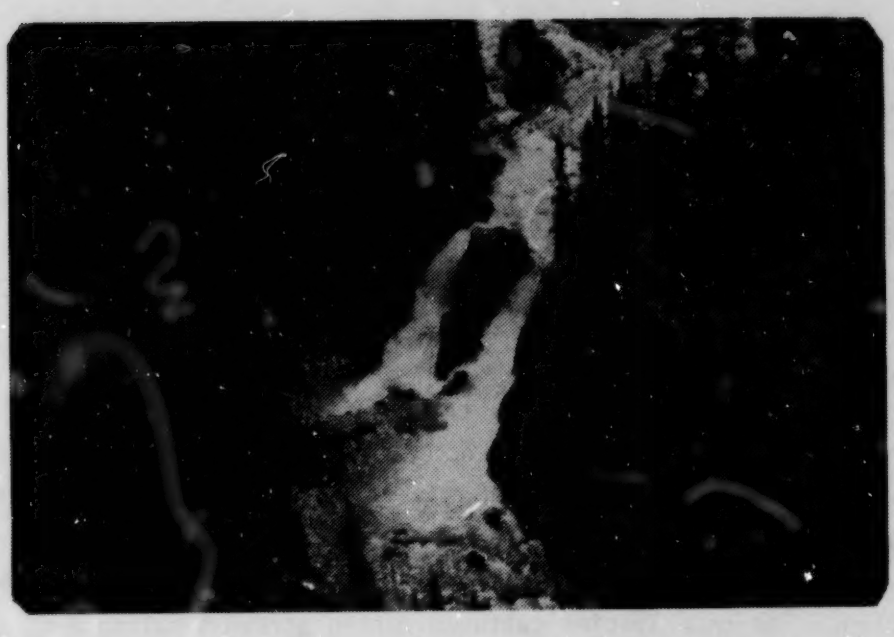

Plate #12. 5 m falls on Ferry Cr. Dolly Varden were found above this point.

Plate #13. 15 m falls on Snowdrift Cr. Both Dolly Varden and rainbow were found above this point.

Settea Creek has Dolly Varden throughout the system, and probably grayling, mountain whitefish and rainbow in the lower reaches.

Access to most other tributaries to the upper Turnagain appears to be blocked by falls or chutes but few of these smaller streams were sampled, and further anomalies may exist.

2.2.3 Eagle River System

From lake sampling data, lake trout, arctic grayling, mountain whitefish and longnose suckers appear to occur throughout most of the Eagle River system. Dolly Varden were captured only at Moose Lakes in the Little Eagle drainage. However, from the pattern of distribution observed in the Turnagain, it seems likely that this species is also present in other parts of the system. The only species captured during stream sampling in the Eagle system were grayling (several locations) and lake trout (one location, near Eaglehead Lake).

No fish were sampled from the Little Eagle River, itself, but lake trout, grayling, whitefish, Dolly Varden, suckers and lake chub (Couesius plumbeus) were captured in tributary lakes. It seems likely that some or all of these species are present where suitable habitats occur in the mainstem Little Eagle River.

Many of the smaller tributaries in the Eagle system were not sampled and therefore have no fish distribution information.

2.2.4 Zuback Creek

Dolly Varden were found in the lower reaches of Zuback Creek. No fish were captured above the impassable falls in reach 3. It is likely that these upper reaches are barren, as there is little or no over-wintering habitat.

2.3 Fish Habitat

Several general comments can be made regarding fish habitat throughout the study area.

The most important general characteristic is the lack of diversity of habitat types within the study area. Stream channels are mainly shallow with little variation in depth or substrate composition. Streamflows tend to be uniform and swift, with few "breaks" caused by deepenings in the channel or protruding boulders. There are very few pools in most systems and this, combined with the high streamflow velocities and shallow water depths leads to very poor holding conditions for adult fish. The uniform, swift flows also afford few good main channel rearing areas. Suitable rearing areas are generally restricted to side or back channels (see Plate #14).

The exceptions to this overall lack of diversity, are those areas which have bedrock control, and those with very low gradients. Reaches with a significant amount of bedrock generally have more pools and a greater variation in flow conditions (see Plate #15). Low gradient, meandering reaches allow for greater development of bars and pools, and thus, more diversity or habitat (see Plates #16 and #17).

Another characteristic of fish habitat in the area is the scarcity of suitable cover. In virtually all parts of the study area, forest cover is either very sparse, or lacking altogether. The result is an absence of crown cover over stream channels and a lack of large, stable debris to provide in-stream cover for fish. The only cover available in most areas is a limited amount of undercut bank habitat and a trace of overhanging vegetation (arctic willow, etc.).

Individual reach descriptions and fish habitat evaluations have been compiled for the entire study area. These are presented in Appendix I.

Plate #14. Photo showing typical habitat. Note the swift, uniform flow and lack of pools. The only suitable rearing areas are found in side and back channels. Also note the lack of cover and debris. Photo is Hard Creek, Reach 3.

Plate #15. Example of habitat diversity generated by bedrock control - Turnagain R., Reach 104.

Plates #16 and #17. Typical low-gradient areas showing increased habitat diversity and better adult holding areas. Plate #16 - Kutcho Creek, Reach 7. Plate # 17 - Unnamed tributary to Rainbow Lake (North), Reach 3.

2.4 Fish Age and Growth

2.4.1 Growth Rates

In general, sport fish growth rates would be expected to be quite slow within the study area due to the relatively low TDS values (e.g. 54 mg/l in Rainbow Lake (South)), the low water temperatures, and the short summer growth period.

Scale and otolith samples were taken from all lake populations surveyed. At present, however, age analysis is only available for Rainbow Lake (South). Growth rates and age-class structure may differ in populations from other waterbodies in the area due to slightly different water quality, water temperature regimes, species composition, etc.

Mean fork lengths per age-class for Rainbow Lake (South) rainbow and mountain whitefish, and Dolly Varden are shown in Table 1. A simple comparison of mean age-class lengths for Rainbow Lake (South) rainbow and mountain whitefish populations with those of several other populations is shown in Table 2 and Table 3. These relationships are also illustrated in Figures 8 and 9. Raw data from Rainbow Lake (South) fish sampling is presented in Appendix II.

Rainbow trout growth rates in Rainbow Lake (South) appear comparable to those of Spatsizi Parks lakes (Osmond-Jones, 1977), which have similar species composition, elevations, and latitude. Growth rates appear higher in Tatlatui Park lakes (Osmond-Jones, 1977), which have rainbow trout in monoculture. Statistical analyses would be necessary to properly verify these observations.

Growth rates of mountain whitefish in Rainbow Lake (South) appear similar to those of Spatsizi Park Lakes, however Rainbow Lake (South) has several older age classes represented.

Only one age 4+ and no age 5+ or 6+ mountain whitefish were captured during fish sampling in Rainbow Lake (South). Fish sampling in Rainbow Lake

(South) and Kutcho Creek by consultants during fall 1979, showed an identical gap in age classes between ages 3+ and 7+ years (Kristensen, 1980). Missing age classes are usually interpreted as indicating that spawning failure has occurred in a population due to some environmental factor. Such a large gap in age classes, however, may simply indicate that 4+, 5+, and 6+ age groups utilize a specific portion of the lake (perhaps mid-water) and were missed during sampling.

Only 13 Dolly Varden were sampled from Rainbow Lake (South), so comparisons with other populations have not been made due to the small sample size.

2.4.2 Age at Maturity

Several age 3+ rainbow trout from Rainbow Lake (South) were determined to be maturing, which indicates that they may spawn the following spring at age 4+ years. Eighty percent of rainbow aged 5+ were maturing, while two age 6+ fish showed no sign of maturity. Kristensen (1980) reported that rainbow trout from the Kutcho Creek/Rainbow Lake (South) system first mature at age 5+ (i.e. spawn at age 6+). From these observations, it appears that rainbow in this population may first spawn as early as age 4+ and as late as 7+, with the majority maturing at age 5+. Scott and Crossman (1973) report that the usual age at maturity for rainbow trout is 3-5 years.

Sexual maturity in mountain whitefish from Rainbow Lake (South) occurs between ages 5+ and 7+ years. No age 5+ and 6+ fish were captured, while all fish aged 7+ or older were mature. These observations are compatible with data collected by consultants in 1979 (Kristensen, 1980).

The youngest mature Dolly Varden captured from Rainbow Lake (South) was aged 7+ years. The average age at sexual maturity could not be accurately determined, however, due to the small sample size.

TABLE 1. MEAN FORK LENGTH AND STANDARD DEVIATION OF RAINBOW TROUT, MOUNTAIN WHITEFISH, AND DOLLY VARDEN AGE-CLASSES FROM SOUTH RAINBOW LAKE POPULATIONS (July 27, 1980).

Rainbow Trout	1+	2+	3+	4+	5+	6+	7+	8+	9+
$\bar{x}$ (cm)	11.95	14.10	21.68	27.53	30.35	37.29	40.55	43.87	45.10
S.D.	1.77	-	3.66	1.57	3.61	3.18	2.83	2.96	2.38
Range (cm)	10.7-13.2	-	18.2-25.5	26.3-29.3	24.0-35.5	33.0-40.8	34.3-43.0	40.8-46.7	42.4-49.9
(n)	2	1	4	3	10	9	10	3	4

Mountain Whitefish	2+	3+	4+	5+	6+	7+	8+	9+	10+	11+	12+
$\bar{x}$ (cm)	13.46	21.30	23.20	-	-	31.55	33.55	35.82	37.04	37.80	39.43
S.D.	0.41	-	-	-	-	0.61	1.19	1.47	1.60	-	1.31
Range (cm)	13.1-14.0	-	-	-	-	30.1-32.3	32.1-35.6	34.2-38.8	34.2-38.0	-	38.4-40.9
(n)	5	1	1	0	0	10	15	6	5	1	3

Dolly Varden	5+	6+	7+	8+	9+	10+	11+	12+
$\bar{x}$ (cm)	23.80	25.90	28.60	31.40	32.50	41.50	-	52.50
S.D.	2.25	2.08	3.41	-	-	-	-	-
Range (cm)	21.2-25.2	23.5-27.2	24.7-31.0	-	-	-	-	-
(n)	3	3	3	1	1	1	-	1

TABLE 2. COMPARISON OF RAINBOW TROUT AGE-CLASS LENGTHS FROM VARIOUS LOCATIONS

Location	Authors	Mean Total Length*/Age class (cm)								
		1+	2+	3+	4+	5+	6+	7+	8+	9+
South Rainbow Lake, B.C.	Pendray, 1982	12.9	15.1	23.2	29.5	32.5	39.9	43.5	47.0	48.3
Spatisizi Park Lakes, B.C. (combined means for 11 lakes)	Osmond-Jones, 1977	11.2	13.9	24.4	27.2	31.8	38.0	43.1		
Tatlatui Park Lakes, B.C. (combined means for 5 lakes - pure culture rainbow	Osmond-Jones, 1977	12.4	14.7	28.1	36.4	41.1	48.5	50.9	55.7	
Western Canada Lakes (combined means from several sources)	Carlander, 1969	17.0	25.4	27.7	29.7	35.6	41.4	49.5		

* All fork lengths converted to total length by the following formula (from Carlander, 1969): TL = 1.071 FL.

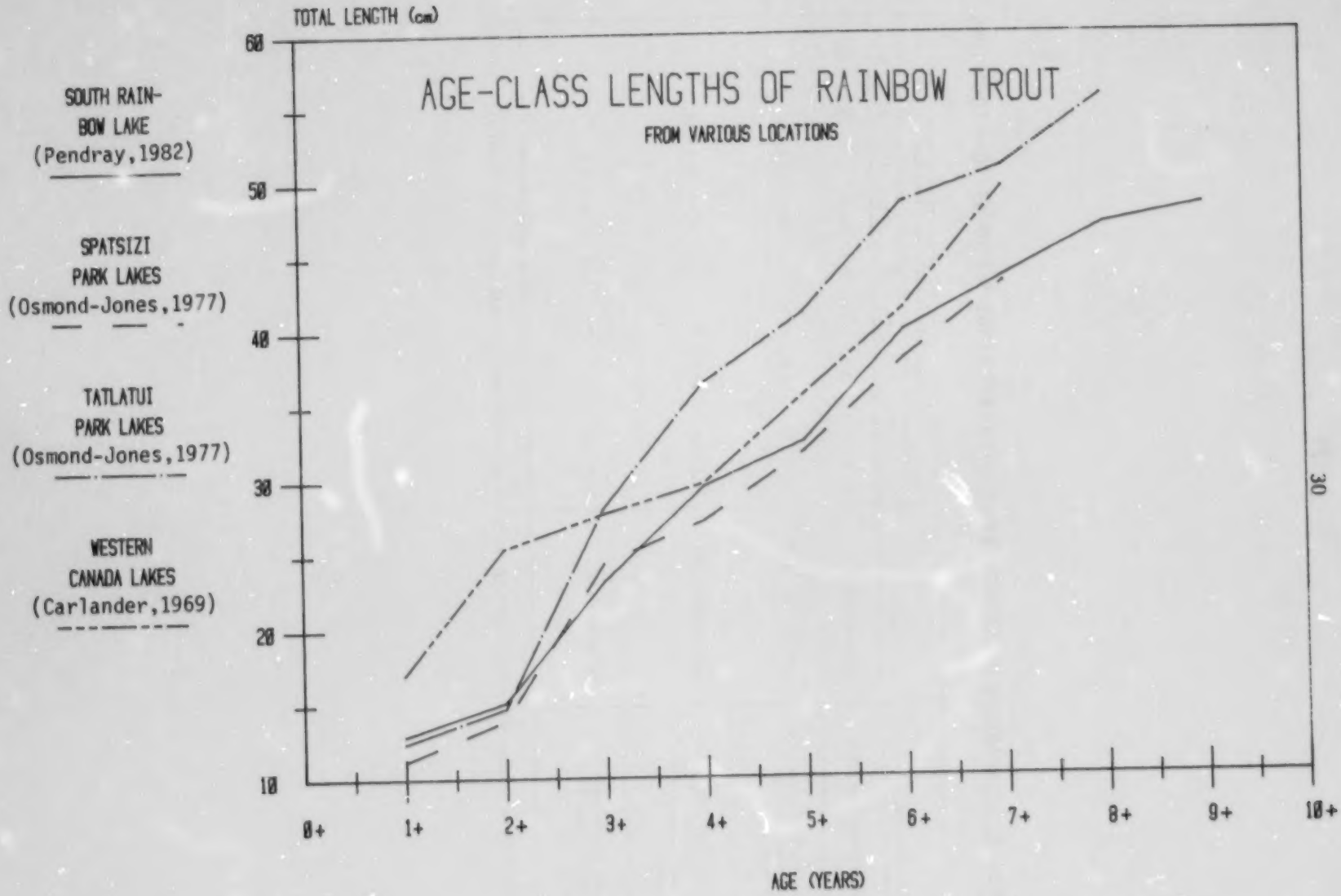

FIGURE 8: COMPARISON OF RAINBOW TROUT AGE-CLASS LENGTHS FROM VARIOUS LOCATIONS

TABLE 3. COMPARISON OF MOUNTAIN WHITEFISH AGE-CLASS LENGTHS FROM VARIOUS LOCATIONS

Location	Authors	Mean Total Length*/Age class (cm)										
		2+	3+	4+	5+	6+	7+	8+	9+	10+	11+	12+
South Rainbow Lake, B.C.	Pendray, 1982	14.9	23.4	26.5	-	-	34.8	36.9	39.4	40.7	41.6	43.3
Spatisizi Park Lakes, B.C. (combined means for 7 lakes)	Osmond-Jones, 1977	14.0	15.6	24.6	26.4	28.7	32.1	34.7	37.4			
Canadian Lakes (combined means from several sources)	Carlander, 1969	19.7	22.9	25.9	29.1	31.0	35.5	37.4	36.7			

* All fork lengths converted to total length by the following formula (from Carlander, 1969): TL = 1.1 FL.

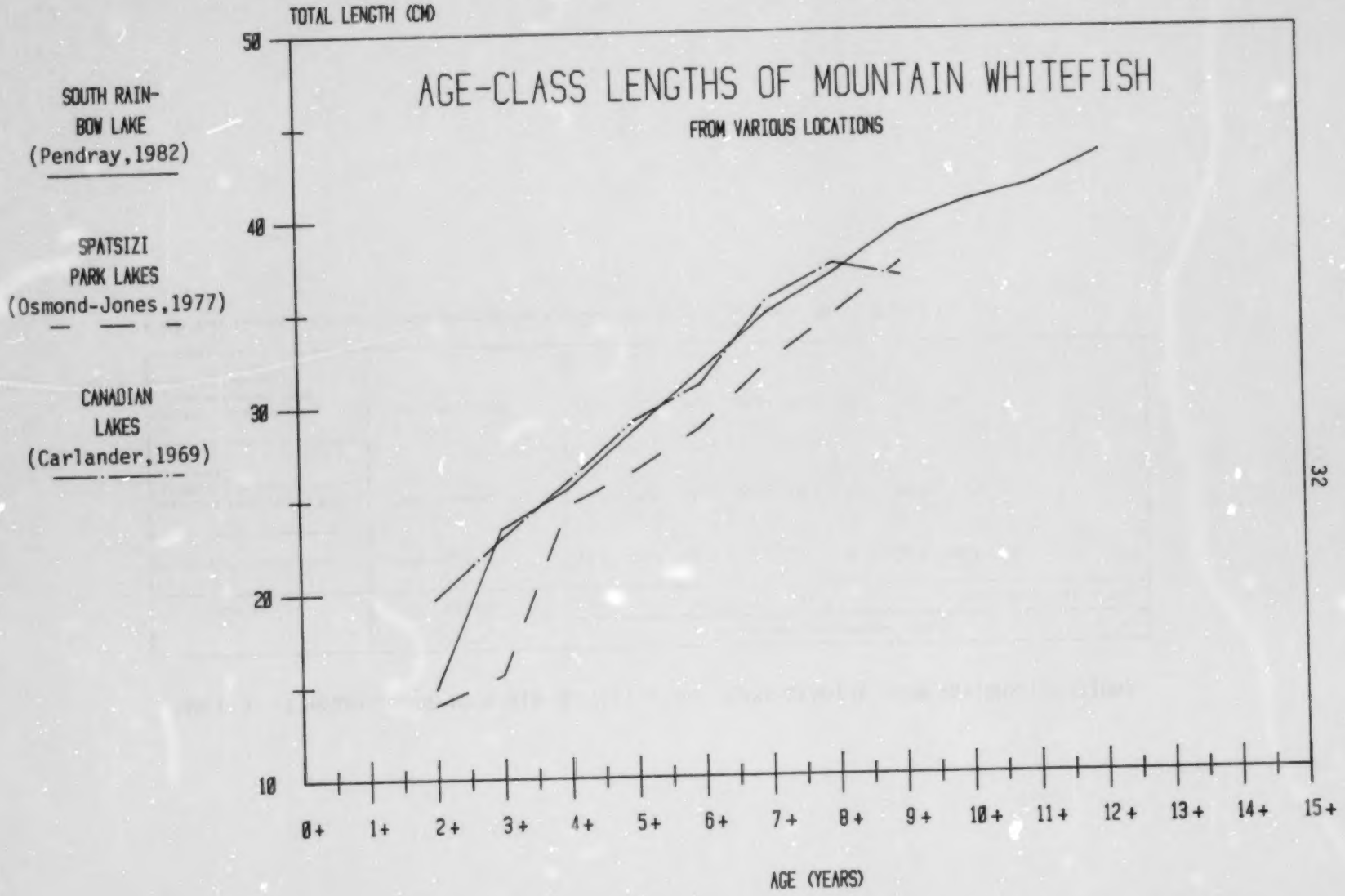

FIGURE 9: COMPARISON OF MOUNTAIN WHITEFISH AGE-CLASS LENGTHS FROM VARIOUS LOCATIONS

2.5 Sport Fisheries Values

In terms of sport fishing values, the most important populations in the region appear to be:

1. The lake trout population of Eaglehead Lake, Hard Lake and probably also the Cry Lake area. Fish captured in lake sampling were large (up to 8 kg +) and appear to be numerous.
2. The rainbow trout populations of Rainbow Lakes, Wolverine Lake, Letain Lake, Turnagain Lake and possibly the Turnagain River. Fish up to 2 kg were sampled.
3. The grayling population of the mainstem Turnagain and Eagle Rivers. Fish up to 1 kg were sampled and appear to be numerous, especially in the Turnagain River.
4. The Dolly Varden population of the Turnagain River and tributaries. This species attains the largest size (in streams) and has the widest distribution of the sport fish in this area.

3.0 PRESENT HABITAT PROTECTION PROBLEMS

3.1 Placer Gold Mining

There are currently several placer mining operations within the study area. Three of the largest operations are on Wheaton Creek, Settea Creek and Faulkner Creek. The Wheaton Creek and Settea Creek mines were viewed while in operation and it was observed that large amounts of sediment were being generated (see Plates #18 and #19). These were considered to be major sources of sediment for the upper Turnagain System.

3.2 Winter Tractor Roads

The present system of tractor roads is very poorly designed from an environmental standpoint. There are numerous fords and other sections which are inundated during periods of high water. The roads are very susceptible to erosion and are a significant source of sediment in some areas (see Plate #22). The system of roads which serves the Jadex Mine site along a tributary to upper Kutcho Creek appears to be a major source of sediment for this area.

Plate #18. The Settea Creek placer gold operation, showing generation of sediment.

Plate #19. Turnagain River looking downstream at the mouth of Wheaton Creek, showing sediment discharge from the Wheaton Creek placer gold operation (photo by M. Fenger).

Plate #20. Cats working on winter roads near Kutcho/Letain confluence.(Photo by B. Fuhr).

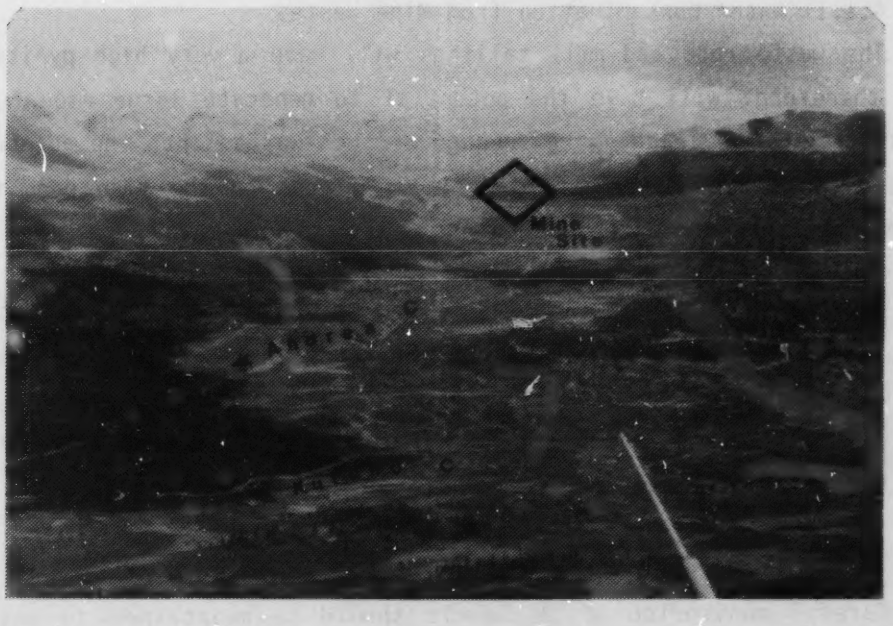

Plate #21. Overall view of Andrea Creek valley. Note approximate location of proposed mine site.

4.0 POTENTIAL IMPACTS OF MINERAL DEVELOPMENT

4.1 Impacts of ESSO Minerals Mine Development

The ESSO Minerals proposed copper/zinc mine development is located along a tributary to upper Kutcho Creek ("Andrea Creek") and will involve a mine shaft, an open pit operation, a milling plant and a camp to house up to 350 workers (R. Webb, 1979) (see Plate #21). Associated with the mine and mill operation will be a large waste rock dump, a tailings pond and a reservoir.

The potential impacts of this development are dealt with in detail in ESSO's Stage I Environmental Report (1979) and will only be outlined briefly in this section.

4.1.1 Water Contamination from Mine Wastes

The waste rock and mill tailings will have a very high pyrite content and, therefore, will have the potential to generate large amounts of sulphuric acid. The leaching or seepage of such wastes into the adjacent water courses could have severely detrimental effects on the fish populations of Andrea Creek, Kutcho Creek and Rainbow Lake.

The company proposes to consider the following preventative measures:-

1. the use of impervious liners in construction of the tailing ponds;
2. pH control of mill effluent and tailings pond supernatant;
3. construction and operation of a reclaim pond (emergency pond);
4. the treatment of mill tailings and waste rock seepage with alkaline material

Careful monitoring of pH levels should be maintained to ensure that these measures are adequate. Consideration should also be given to continue monitoring and control measures following abandonment of the site in order to prevent long-term deterioration of water quality.

Fortunately, the water in Andrea Creek appears to have good buffering qualities which may reduce impacts if leaching and seepage do occur (Kristensen, 1980).

4.1.2 Removal of Water for Mill or Camp Requirements

This impact will be most critical during winter when streamflows are minimal. Removal of up to 40 l/sec. from surface or groundwater sources may reduce or eliminate any overwintering habitat available in Andrea or Kutcho Creeks.

4.1.3 Sedimentation from Construction at Mine or Camp Sites

This impact should be fairly short term, but may continue if unstable materials are left exposed. Construction scheduling and procedures should also take into account the probability of heavy rainfall occurring during the summer months.

4.2 Impacts of Access Road Development

A prerequisite for development of the Kutcho Creek mine site is the construction of an all-weather access road, approximately 114 km in length, to connect the mine to the Stewart-Cassiar Highway. The general corridor for this road is shown in Figure 2.

4.2.1 Impacts of Road Construction

The site-specific routing of this road has not been confirmed, so this section will deal only with general construction impacts.

Probably the most important impact of road construction in this area will involve the location of culverts. Culverts tend to inhibit the passage of most sport fish. This is especially important for relatively weak-swimming species such as arctic grayling and for juveniles, which tend to migrate frequently in response to water fluctuations.

Another obvious impact is a possible increase in siltation during the construction phase. The extent of this impact will depend on specific route location. In this case, however, the completion of the all-weather road may have overall beneficial effects on siltation, as it may eliminate use of the poorly-designed winter road system.

In terms of location, a possible problem area will be the crossing of the upper Turnagain River. The whole upper Turnagain valley has a very broad floodplain and there appears to be few (if any) crossing sites which would not be subject to flooding at peak water levels.

4.2.2 Impacts of Increased Access

Improved access will undoubtedly lead to greatly increased exploitation of sports fish populations in the area. At present, there are reports of very good angling success in various lakes and streams in the region. Fish productivity, however, appears to be relatively low, and with increased angling pressure it is doubtful that viable, quality fisheries could be maintained.

This may be especially true for the grayling and lake trout populations, which are known to be particularly susceptible to angling pressure (Vincent, 1963; Falk and Gillman, 1975). The rainbow trout populations of the upper Turnagain system may also come under heavy pressure, as this species tends to be highly sought after by anglers.

Special gear or catch restrictions may become necessary in order to maintain quality sport fisheries in the area.

Another result of the improved access will be the inevitable increase in exploitation of other resources in the area, including placer gold, jade, asbestos, and other mineral deposits.

5.0 ENHANCEMENT/MITIGATION OPTIONS

One of the main habitat limitations in the area appears to be a general lack of diversity and, in particular, a shortage of suitable holding areas. Therefore, a possible enhancement technique in some areas may be the manipulation of habitat to increase complexity. This might be done (at least on an experimental basis), by placing boulders or other structures in the stream channel in areas where waste rock from construction is readily available.

Further study is necessary to identify other enhancement opportunities. However, it may be that due to low overall productivity, cold water temperatures, etc., the benefits of enhancement would be limited. The emphasis in this area may have to be on protection of existing stocks, rather than enhancement.

6.0 RECOMMENDATIONS FOR ADDITIONAL STUDY

1. Further fish sampling is necessary to more accurately determine fish distribution and potential stream carrying capacities. Fish sampling should be done in the late spring (June, early July) and early fall (September) to avoid the summer rainfall period. Particular emphasis should be placed on determining utilization of the lower reaches of tributaries to major rivers and of reaches immediately adjacent to lakes, as these areas tend to have the most valuable sport fish populations.

2. Further work should be done to determine overwintering utilization of Andrea and upper Kutcho Creeks in order to assess the potential effects of water removal. This work should involve water sampling with ice augers during winter to determine whether potential overwintering areas exist and, perhaps, an attempt at winter fish sampling.

3. The route of the proposed access road (when confirmed) should be evaluated using the reconnaissance data to flag possible sensitive areas. Sensitive areas will then require further study to determine fish utilization (timing of runs, etc.), so that recommendations can be made regarding construction timing, bridge and culvert location, etc.

4. A water quality monitoring program should be initiated prior to further development in order to determine background loading levels. At present, water quality data has been collected by ESSO Minerals in the immediate vicinity of the proposed mine site ("Andrea" Creek, Kutcho Creek, Rainbow Lake (South)). No water quality monitoring has been done in the remainder of the study area. The development of an access road will undoubtedly accelerate the exploitation of other resources in the area, as well as

possibly increasing sediment loads during construction. A monitoring program should initially concentrate on water bodies in the vicinity of the proposed road corridor and should collect data on suspended sediments, pH, and heavy metals.

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APPENDIX 1

REACH DESCRIPTIONS AND FISH HABITAT EVALUATIONS

The following table (Table AI) is a reach by reach description and habitat evaluation for all streams surveyed within the study area. This table was compiled to aid in interpretation of reach and point card data and to "flag" reaches with relatively higher fisheries values. Included in the table is an evaluation of the suitability of the habitat for "adult holding" and "fry rearing". These two fish utilization components were chosen primarily because suitable holding and rearing habitat appears to be quite limited in this area. Therefore, reaches which are rated "high" for holding or rearing, should be considered to have significantly higher fisheries values relative to other reaches in the area.

Obviously, the evaluations are quite general in scope, as we are considering as a single group, five different species of sport fish, each with slightly different habitat preferences. However, the two components chosen were thought to be relatively species independent. Other fish utilization components considered were suitability for spawning and for overwintering. These components were not given ratings, but were included in the habitat descriptions as general comments only.

The "adult holding" evaluation was based primarily on percent pools, average streamflow velocity, and average depth. The values for percent pools were taken directly from the reach data cards, while average velocities were estimated from point sample measurements, surface expression (i.e. placid expression was considered to have low velocity), and photographs. In some cases, velocity was inferred from an estimate of reach gradient (i.e. low gradient was considered to have low velocity). Average depths were estimated from point sample measurements and photographs. Cover parameters such as overhang and stable debris were not considered as they were generally negligible throughout the study area.

Adult holding suitability was assumed to increase with more pools, lower velocities, and deeper water (i.e. using these guidelines, a lake is the perfect holding habitat).

Rough guidelines used in evaluating the parameters for adult holding were as follows:-

- pools - 0-19% - low rating
  - 40% or more - high rating
- estimated velocity - less than 0.5 m/sec. - high rating
- greater than 1.0 m/sec. - low rating

The depth parameter was used only as a subjective qualifier for the pool and velocity parameters.

The "fry rearing" evaluation was based primarily on side and back channel presence and estimated velocity. Other factors, such as presence of undercut banks or extensive shallow riffle areas were used as qualifiers.

Fry rearing suitability was assumed to increase with more side and back channels, and lower velocities. The presence of undercut banks or shallow riffles was also assumed to increase the suitability for fry rearing. Side channel presence was derived directly from the reach cards, while velocity was estimated as above.

Guidelines for evaluating velocity were similar to those for holding, with the difference that low velocities received a disproportionately heavy weighting, as follows:-

- less than 0.5 m/sec. - high rating
- 0.6 - 1 m/sec. - low rating
- greater than 1 m/sec. - very low or nil rating

Plates #A1 and #A2 show two different reaches with examples of habitat ratings and associated reach parameters.

It should be stressed that the ratings generated are "subjective" and are intended to serve only as very general indicators of fish habitat suitability. The ratings should also be used as a comparison between reaches within this study area. A reach with a high rating for "adult holding" in the region would not necessarily receive a similar rating when compared with other regions of the Province.

Plate A1. Reach 3 of tributary 17-3200-590-150.

Habitat Ratings:

Adult holding - Moderate
Fry rearing - High

Selected Reach Parameters

Total pools - 10%
Side channels - High
Flow character- Swirling
Bed material - 60% fines, 40% gravel, trace of larges
Channel cover - 0%
Stable debris - 0%
Width - 18 m

Estimated velocity - 0.6 - 1.0 m/sec.
Actual velocity measured at point sample - 1.0 m/sec.

Plate A2. Reach 1, Letain Creek.

Habitat Ratings:

Adult holding - Low
Fry rearing - Low

Selected Reach Parameters

Total pools - 10%
Side channels - Low
Flow character- Rolling/Broken
Bed material - 10% fines, 30% gravel, 60% larges
Channel cover - 0%
Stable debris - 0%
Width - 14 m

Estimated velocity - >1.0 m/sec.
Actual velocity measured at point sample - 2.0 m/sec.

TABLE A1. REACH DESCRIPTIONS AND HABITAT EVALUATIONS FOR UPPER TURNAGAIN RIVER STUDY AREA

List of abbreviations:

DV - Dolly Varden
GR - Arctic grayling
LKC - Lake chub
LSu - Longnose Sucker
LT - Lake trout
MW - Mountain whitefish
RB - Rainbow trout
SP - one or more species present
Ø - no fish present
? - fish data lacking or inconclusive

Stream (Watershed Code)	Reach	Reach Length (km)	Description	Chan. Width (m)	Fish Species Present (or suspect)	Habitat Evaluations		Comments
						Adult Holding	Fry Rearing	
Turnagain R. (17-3200)	101	2.2	Broad channel, moderate depth, and swift flow.	60	DV, GR, (LSu, LT, MW, RB)	Moderate -20% pools -sufficient depth for holding	Low -low side/back channels -swift flow	-Rearing is limited to channel margins and the few back channels.
	102	1.8	Entrenched bedrock canyon with impassible falls.	30	?	Low -canyon/falls area with no suitable pools	Low -canyon/falls area	-RB or DV may be present in this reach under low flow conditions.
	103	3.6	Confined channel. Swift flow with rapids throughout.	40	(DV, GR, LSu, LT, MW, RB)	Low -0% pools -rapids throughout	Low -few side channels -very swift flow	-May be some rearing area available at lower flows.
	104	60.5	Frequently confined channel. Moderate velocity. Uniform depth.	40	(DV, GR, LSu, LT, MW, RB)	High -10% pools, but depth and flow suitable for holding in most of reach	Moderate -moderate side channels -some good shallow riffle areas	-Main channel rearing areas would be more extensive at lower flows.
	105	7.1	Frequently confined. Some bedrock canyon areas	30	(DV, GR, LSu, LT, MW, RB)	High -20% pools -depth and flow suitable for holding in most of reach	Moderate -some good shallow riffle areas	-Main channel rearing areas would be more extensive at lower flows
	106	9.4	Broad valley. Occasional confinement Many areas with multiple channel flow.	35	(DV, GR, LSu, LT, MW, RB)	High -40% pools -depth and flow suitable throughout	High -high side channels -good shallow riffle areas	
	107	2.6	Shallow unnamed lake.	-	(DV, GR, LSu, LT, MW, RB)			
	108	2.5	Broad valley. Occasional confinement Low velocity. Meandering	35	(DV, GR, LSu, LT, MW, RB)	High -50% pools -low velocity	High -moderate side channels -low velocity	-Wheaton Creek, a major sediment source, enters in this reach.

TABLE A1 CONT'D.

Stream (Watershed Code)	Reach	Reach Length (km)	Description	Chan. Width (m)	Fish Species Present (or suspect)	Habitat Evaluations		Comments
						Adult Holding	Fry Rearing	
Turnagain R. (17-3200)	109	2.3	Unnamed lake		(DV, GR, LSu, LT, MW, RB)			
	110	7.3	Broad valley. Occasional confinement. Low velocity. Some areas of multiple channel flow.	30	(DV, GR, LSu, LT, MW, RB)	High -20% pools -low velocity and ample depth	High -moderate side channels -same good back channel rearing areas	-60% gravels - may be an important spawning area.
	111	1.2	Unnamed lake - alias. Three Kettle Lake		GR, LSu, LT, MW, RB, (DV)			
	112	2.4	Occasional confinement Low velocity. Single channel	35	(DV, GR, LSu, LT, MW, RB)	High -20% pools -low velocity and ample depth	Moderate -low side channels -low velocity, some back channels	
	113	11.5	Occasional confinement Low velocity. Irregular meanders. Many oxbows and cut-offs.	30	(DV, GR, LSu, LT, MW, RB)	High -50% pools -low velocity	High -high side/back channels -low velocity	
	114	0.8	Unnamed lake.		(DV, GR, LSu, LT, MW, RB)			
	115	1.3	Unconfined, marshy area. Very low gradient.	4	GR, MW, RB, LSu, (DV, LT)	High -70% pools -low gradient	High -many side/back channels -very low gradient	-Substrate mostly fines.
	116	4.1	Turnagain Lake		GR, LSu, LT, MW, RB, (DV)			

TABLE A1 CONT'D.

Strean (Watershed Code)	Reach	Reach Length (km)	Description	Chan. Width (m)	Fish Species Present (or suspect)	Habitat Evaluations		Comments
						Adult Holding	Fry Rearing	
Kutcho C. (17-3200-590)	1	2.8	Confined channel with bedrock control. Swift flow with rapids throughout.	45	(RB, DV, MW, GR)	Low -very high velocity -20% pools	Low -low side/back channels -high velocity	-Rapids near mouth may form a velocity barrier to some species.
	2	12.0	Confined with bedrock control. Swift flow with some rapids. Channel has variety of depth and flow due to bedrock influence.	45	RB (DV, MW)	Moderate -20% pools -pools are deep and stable	Low -low side/back channels -swift flow	-Large boulders break flow and increase holding area.
	3	9.2	Mostly wide and shallow with some rapids and bedrock control. Several broad, placid areas.	60	(RB, DV, MW)	Moderate -20% pools -lower gradient	Moderate -low side/back channels, but several broad shallow pools - lots of shallow riffle areas	-May be an important spawning and rearing area for Rainbow Lake.
	4	6.7	Rainbow Lake (South)		RB, DV, MW			
	5	2.8	Broad valley. Low gradient. Shallow.	30	RB, DV, MW	Moderate -40% pools -moderate velocity -shallow	Moderate -good side and back channel rearing areas	-May be an important spawning and rearing area for lake populations - 50% gravels.
	6	11.1	Frequently confined. Shallow and swift flowing.	22	RB, DV, MW	Low -20% pools -swift flow	Low -low side channels -swift flow	
	7	10.1	Broad valley. Low gradient. Meandering with oxbows.	25	RB, DV, MW	Moderate -20% pools -low velocity	High -high side/back channels -low velocity	-May be some suitable overwintering habitat in deeper pools.
	8	10.0	Occasionally confined. Shallow. Fairly low gradient. Irregular meanders.	13	DV, MW, (RB)	Moderate -20% pools -moderate velocity	Moderate -moderate side/back channels and velocity	-Mostly shallow - no obvious overwintering areas.

TABLE A1 CONT'D.

Stream (Watershed Code)	Reach	Reach Length (km)	Description	Chan. Width (m)	Fish Species Present (or suspect)	Habitat Evaluations		Comments
						Adult Holding	Fry Rearing	
Kutcho C. (17-3200-590)	9	2.0	Confined. Steep gradient, bedrock controlled area. Chutes and rapids present.	6	DV	Low -10% pools -steep gradient	Low -low side/back channels -steep gradient	
	10	2.1	Shallow. Fairly low gradient. Swift flowing. Headwater area.	4	DV	Low -5% pools -swift flow	Low -low side/back channels -swift flow	-Shallow - no obvious overwintering habitat.
Faulkner C. (17-3200-590-020)	1	0.4	Shallow. Moderate gradient. Swift flow. Trace of bedrock.	10	(SP)	Low -5% pools -swift flow	Low -some side channels, but flow is swift	-Lower portion of reach has less gradient and may be more suitable for holding and rearing.
	2	1.9	Shallow and swift flowing.	13	?	Low -5% pools -swift flow	Low -some side channels, but flow is swift	-Mostly shallow - no obvious overwintering habitat.
	3	6.4	Moderate gradient. Shallow ans swift flowing.	10	?	Low -5% pools -swift flows	Low -low side channels -swift flow	
Unnamed C. (17-3200-590-020 -050)	1	2.7	High gradient. Headwater area.	6	?	Low -10% pools -steep gradient	Low -low side channel -steep gradient	
Unnamed C. (17-3200-590-100)	1	2.7	Confined channel. Moderate gradient. Swift flow with rapids and cascades.	10	(SP)	Low -10% pools -moderate gradient	Low -low side/back channels -swift flow	-Lower 400 m of reach has less gradient. -This reach may be a velocity barrier to some species.
	2	3.4	Shallow. Lower gradient. Swift flow.	18	?	Low -10% pools -swift flow	Moderate -moderate side/back channels	-No obvious overwintering habitat.
	3	1.7	Confined channel. Moderate gradient. Swift flow with rapids.	7	?	Low -10% pools -swift flow	Low -low side/back channel -swift flow	-No obvious overwintering habitat.

TABLE A1 CONT'D.

Stream (Watershed Code)	Reach	Reach Length (km)	Description	Chan. Width (m)	Fish Species Present (or suspect)	Habitat Evaluations		Comments
						Adult Holding	Fry Rearing	
Unnamed C. (17-3200-590-140)	1	2.3	Confined channel. Moderate gradient. Very swift flow with rapids and cascades.	10	(SP)	Low -5% pools -very swift flow	Low -low side/back channels -swift flow	-Lower 300 m of the reach has less gradient.
	2	2.5	Shallow. Low gradient. Meandering. Some beaver dams.	14	?	Moderate -20% pools -low gradient	Moderate -moderate side/back channel -low gradient	-May be utilized by species from Kutcho Creek. -No obvious overwintering habitat.
	3	3.8	Confined channel. Moderate gradient. Swift flow with rapids.	8	?	Low -10% pools -swift flow	Low -low side/back channels -swift flow	
Unnamed C. (17-3200-590-140-020)	1	1.0	Confined channel. Moderate gradient. Swift flow with rapids.	5	?	Low -10% pools -swift flow	Low -low side/back channels -swift flow	-This tributary has a small lake at the head.
Unnamed C. (17-3200-590-150)	1	2.5	Very swift flow with rapids throughout.	25	(DV, MW, RB)	Low -10% pools -swift flows	Low -low side/back channels -swift flow	-Short section just downstream from North Rainbow Lake is lower gradient and may be utilized for spawning and rearing.
	2	5.6	North Rainbow Lake.		(DV, MW, RB)			
	3	6.1	Broad valley. Low gradient. (<1%). Meandering.	18	DV (MW, RB)	Moderate -20% pools -low gradient, low velocity.	High -high side/back channels -low gradient -some undercut banks	-May be an important spawning and rearing area for North Rainbow Lake - large amounts of suitable spawning gravels.
	4	3.4	Confined channel. Moderate gradient. Swift flow.	12	(SP)	Low -20% pools -swift flow	Low -low side/back channels -swift flow	-Probably utilized by species from North Rainbow Lake. (DV, MW, RB).

TABLE A1 CONT'D.

Stream (Watershed Code)	Reach	Reach Length (km)	Description	Chan. Width (m)	Fish Species Present (or suspect)	Habitat Evaluations		Comments
						Adult Holding	Fry Rearing	
Unnamed C. (17-3200-590-150)	5	8.8	Low gradient. Meandering.	13	(SP)	High -50% pools -low gradient	Moderate -moderate side/ back channel -low gradient	-Probably utilized by species from North Rainbow Lake (DV, MW, RB) - Large amounts of suitable spawning gravel available.
Unnamed C. (17-3200-590-150 -020)	1	0.9	Low gradient, meandering area adjacent to lake.	11	DV (MW, RB)	Moderate -10% pools, but very low gradient and velocity	High -moderate side channels -many back channel areas	-May be an important spawning and rearing area for North Rainbow Lake.
	2	2.0	High gradient, confined canyon area with cascades and small falls.	6	(SP)	Low -high gradient, high velocity	Low -high gradient	
	3	5.2	Moderate gradient. Shallow, with swift flow.	6	?	Low -20% pools -swift flow	Low -moderate side/ back channels -swift flow	
Unnamed C. (17-3200-590-150 -080)	1	0.9	Confined channel. Moderate gradient. Swift, broken flow.	7	(DV, MW, RB)	Low -10% pools -swift flow	Low -low side channels -swift flow	
	2	4.3	Moderate gradient. Shallow. Swift flow.	8	?	Low -10% pools -swift flow	Low -low side/back channels -swift flow	-No obvious overwintering habitat.
	3	1.7	Confined channel. Steep gradient. Zone of cascades.	6	?	Low -10% pools -steep gradient	Low -steep gradient	
Unnamed C. (17-3200-590-190)	1	5.7	Broad, open valley. Low gradient (<1%).	10	(DV, MW, RB)	Moderate -30% pools -low gradient	Moderate -low gradient -good back channel areas	-May be an important spawning and rearing area.
	2	6.0	Broad valley. Mostly low gradient (approx. 1%)	7	(DV, MW, RB)	Moderate -20% pools -low gradient	Moderate -low gradient -good back channel areas	-This reach may be a crossover point between Pacific and Arctic drainages.

TABLE A1 CONT'D.

Stream (Watershed Code)	Reach	Reach Length (km)	Description	Chan. Width (m)	Fish Species Present (or suspect)	Habitat Evaluations		Comments
						Adult Holding	Fry Rearing	
Unnamed C. (17-3200-590-190)	3	1.1	Steeper gradient. Swift flow.	5	(SP)	—	—	-Only partial habitat information available - suspect adult holding and rearing are low.
Unnamed C. (17-3200-590-200)	1	4.6	Moderate gradient. Shallow and swift flowing.	12	(DV, MW, RB)	Low -10% pools -swift flow	Low -low side/back channels -swift flow	
	2	2.1	Lower gradient (approx. 1%). Shallow. Moderate velocity.	10	(DV)	Low -10% pools -shallow	Moderate -moderate side/back channels -low gradient	-Other species may also be present in this reach - Large amounts of suitable spawning gravel present.
	3	0.9	Confined channel. Higher gradient. Swift flow.	8	(DV)	Low -10% pools -swift flow	Low -low side/back channels -swift flow	
	4	0.9	Lower gradient (approx. 1%). Shallow. Moderate velocity.	8	DV	Moderate -20% pools -low gradient	Moderate -moderate side/back channels -low gradient	-Large amounts of suitable spawning gravel present.
	5	2.1	Confined channel. Moderate gradient. Swift flow.	5	?	Low -20% pools -moderate gradient	Low -low side/back channels	
Letain C. (17-3200-590-220)	1	10.0	Shallow and swift flowing. Uniform depth and flow.	14	DV, RB, (MW)	Low -10% pools -swift flow (>1 m/sec)	Low -low side/back channels -swift flow	
	2	1.3	Confined canyon area with cascades.	8	(DV, RB)	Moderate -20% pools -several large pools below cascades	Low -low side/back channel -steep gradient	-Pools below cascades may be used for overwintering.

TABLE A1 CONT'D.

Stream (Watershed Code)	Reach	Reach Length (km)	Description	Chan. Width (m)	Fish Species Present (or suspect)	Habitat Evaluations		Comments
						Adult Holding	Fry Rearing	
Letain C. (17-3200-590-220)	3	6.4	Moderate gradient. Mostly swift flowing.	9	DV, RB	Low -10% pools -swift flow (>1 m/sec.)	Moderate -moderate side channels -some good back channel areas	
	4	0.7	Small Lake.		(DV, RB)			
	5	1.0	Shallow. Moderate flow with placid sections.	10	(DV, RB)	Moderate -large placid sections in reach	Moderate -low side channel, but large, shallow placid sections available	-May be an important spawning area for Letain Lake - 50% gravels.
	6	-	Letain Lake.		DV, RB			
	7	2.8	Broad valley. Low gradient (<1%). Meandering.	8	DV, RB	High -40% pools -low gradient	High -high side/back channels -low gradient	-May be an important spawning (50% gravels) and rearing area for Letain Lake populations.
	8	2.5	Confined channel. Moderate gradient. Shallow with swift flow.	6	(DV, RB)	Low -10% pools -swift flow	Low -low side/back channels -swift flow	-Small lakes present in headwater.
Blick C. (17-3200-590-220 -010)	1	2.0	Mostly shallow and swift with pools formed by beaver dams.	12	(DV, MW, RB)	Moderate -20% pools-some placid sections behind beaver dams	Moderate -low side channels, but many back channels and large placid areas	
	2	1.1	Wolverine Lake.	8	MW, RB, (DV)			
	3	7.8	Broad valley. Low gradient (<1%). Meandering with oxbows.	11	RB, (DV, MW)	High -40% pools -low gradient	High -moderate side channels -high back channels and cut-offs	-May be an important spawning (50% gravels) and rearing area for Wolverine Lake populations.

TABLE A1 CONT'D.

Stream (Watershed Code)	Reach	Reach Length (km)	Description	Chan. Width (m)	Fish Species Present (or suspect)	Habitat Evaluations		Comments
						Adult Holding	Fry Rearing	
Blick C. (17-3200-590-220 -010)	4	3.3	Variable reach with open, meandering sections, confined sections and small lakes.	6	(DV, MW, RB)	——	——	-Only partial habitat information available - Variable habitat.
Bullion C. (17-3200-590-220 -010-050)	1	1.0	Fluvial fan area. Shallow with swift flow.	9	(DV, MW, RB)	Low -10% pools -swift flow	Low -low side channels -swift flow	-Lower portion of the reach has less gradient and may be more suitable for holding and rearing.
	2	1.3	Confined, steep gradient area with rapids and cascades.	8	?	Low -10% pools -steep gradient	Low -steep gradient	-This reach may be a gradient barrier to some species.
	3	4.1	Shallow, swift flowing. Beaver dams in upper portion.	10	?	Low -10% pools -swift flow	Low -low side/back channels -swift flow	-May be some rearing habitat in beaver dam areas near headwaters.
Unnamed C. (17-3200-590-220 -010-090)	1	2.9	Confined channel. Moderate gradient. Swift flowing.	7	(SP)	Low -20% pools -swift flow	Low -low side channels -swift flow	
	2	1.7	Broad valley. Moderate gradient.	7	?	Moderate -20% pools -moderate gradient	Low -low side/back channels	
Unnamed C. (17-3200-590-220 -200)	1	1.1	Confined channel. Fairly steep gradient.	6	(SP)	Moderate -30% pools	Low -low side/back channels -steep gradient	
	2	1.6	Broad valley. Lower gradient. High elevation area. Shallow.	5	?	Moderate -30% pools-low gradient-pools are shallow, however	Low -low side/back channels	-No obvious overwintering areas. -This reach may be barren.
Unnamed C. (17-3200-590-260) ("Andrea C.")	1	0.6	Fluvial fan area. Shallow with swift flow.	20	DV, MW, RB	Low -5% pools -swift flow	Moderate -moderate side/back channels	

TABLE A1 CONT'D.

Stream (Watershed Code)	Reach	Reach Length (km)	Description	Chan. Width (m)	Fish Species Present (or suspect)	Habitat Evaluations		Comments
						Adult Holding	Fry Rearing	
Unnamed C. (17-3200-590-260) ("Andrea C.")	2	2.4	Confined channel. Very swift flowing. Moderate gradient.	12	DV, MW, RB	Low -20% pools -very swift flow	Low -low side/back channels -swift flow	
	3	2.2	Shallow. Swift flowing.	17	DV, MW, RB	Low -0% pools -swift flow	Moderate -moderate side/back channels -swift flow	-No obvious overwintering areas. -50% gravels-may be suitable for spawning.
	4	2.6	Entrenched channel. Shallow bedrock canyon with falls.	12	DV, MW, RB	Moderate -30% pools	Low -low side channels	-Bedrock controlled pools may provide overwintering habitats.
	5	4.5	Shallow. Swift flowing. Moderate gradient.	12	DV, RB	Low -5% pools -swift flow	Low -swift flowing -moderate gradient	-No obvious overwintering areas.
Unnamed C. (17-3200-590-280)	1	1.5	Shallow. Swift flowing. Moderate gradient.	8	(SP)	Low -5% pools -swift flow	Low -low side/back channels -swift flow	
	2	3.4	Lower gradient. Shallow. Swift flowing.	8	?	Moderate -20% pools -lower gradient	Low -low side/back channels -swift flow	
	3	3.8	Moderate gradient. Swift flowing.	5	?	Low -10% pools -swift flow	Low -low side/back channels -swift flow	
Unnamed C. (17-3200-590-360)	1	1.3	Very low gradient (<1%), low velocity reach.	3	(DV)	Low -10% pools -narrow channel	Moderate -low side channels, but some back channels and overhang -low velocity	

TABLE A1 CONT'D.

Stream (Watershed Code)	Reach	Reach Length (km)	Description	Chan. Width (m)	Fish Species Present (or suspect)	Habitat Evaluations		Comments
						Adult Holding	Fry Rearing	
Hard C. (17-3200-640)	1	0.2	Fan area. Shallow. Multi-channel flow. High velocity.	40	DV (GR, LSu, MW, RR)	Low -10% pools -shallow	Low -high side channels, but mostly very swift flowing	
	2	3.5	Confined channel. Moderate gradient. Very swift flow.	25	DV (LSu, MW)	Low -30% pools, but very swift flow with rapids throughout	Low -low side channels -very swift flow	-Habitat may be more suitable at lower flows.
	3	3.5	Occasional confinement. Shallow with swift flow.	25	DV (LSu, MW)	Low -10% pools -swift flow	Low -moderate side channels, but swift flow and few back channels	-Rearing habitat may be more suitable at lower flows.
	4	5.2	Occasional confinement. Slightly lower gradient. Shallow	20	(DV, LSu, MW)	Low -0% pools -shallow	Moderate -moderate side channels, some shallow riffle areas	-50% gravels - may be suitable spawning areas.
	5	4.5	Unconfined. Low gradient. Irregular meanders. Many side and back channels.	20	(DV, LSu, MW)	Moderate -20% pools -low gradient	High -high side/back channels -low gradient	
	6	2.8	Unconfined. Very low gradient. Placid sections.	20	(DV, LSu, MW)	Moderate -20% pools -very low gradient	Moderate -low side channels, but many back channels and shallow placid sections	-Substrate mostly fines. -Some beaver dams present.
	7	3.7	Hard Lake.		LSu, LT, MW, (DV)			
Ferry C. (17-3200-670)	1	1.8	Unconfined channel. Low gradient. Some multiple-channel flow.	25	(SP)	Moderate -50% pools, but shallow	High -moderate side/back channels -low velocity	-50% gravels-some (or all) of the species from Turnagain R. probably utilize this reach for spawning and rearing.

TABLE A1 CONT'D.

Stream (Watershed Code)	Reach	Reach Length (km)	Description	Chan. Width (m)	Fish Species Present (or suspect)	Habitat Evaluations		Comments
						Adult Holding	Fry Rearing	
Ferry C. (17-3200-670)	2	6.2	Frequently confined channel. Moderate gradient. Shallow and swift flowing. One falls present.	20	(DV)	Low -10% pools -swift flow	Low -low side channels -swift flow	
	3	3.0	Frequently confined. Shallow and swift flowing.	15	DV	Low -10% pools -swift flow	Low -low side channels -swift flow	-Small lakes in headwaters.
Bobner C. (17-3200-690)	1	0.5	Fan area. Unconfined channel. Shallow, swift flow.	12	(SP)	Low -10% pools -swift flow	Low -low side channel -swift flow	
	2	2.9	Confined, steep gradient area with a series of falls.	8	(Ø)	Low -10% pools -steep gradient	Low -steep gradient falls area	-Appears to lack overwintering habitat - Probably no fish above falls.
	3	4.5	Moderate gradient. Swift flow.	3	(Ø)	Low	Low	-Probably no fish present. -Lacks overwintering habitat.
Wheaton C. (17-3200-700)	1	0.9	Active fan area. Multiple and shifting channels. Shallow with swift flow.	20	(SP)	Low -5% pools -shallow	Moderate -high side channels, but may be too unstable	-This reach may be utilized by species from Turnagain River. -An area of actively migrating channels.
	2	0.5	Confined channel. Fairly steep gradient. Swift flow. Rock falls.	6	(Ø)	Low -10% pools -swift flow	Low -low side channels -swift flow	-Probably no fish present above falls. -Numerous tractor fords in this reach.
	3	3.9	Frequently confined. Moderate gradient. Shallow, with swift flow.	6	(Ø)	Low -10% pools -swift flow	Low -low side channels -swift flow	-Probably no fish present. -Numerous channel alterations caused by placer mining.

TABLE A1 CONT'D.

Stream (Watershed Code)	Reach	Reach Length (km)	Description	Chan. Width (m)	Fish Species Present (or suspect)	Habitat Evaluations		Comments
						Adult Holding	Fry Rearing	
Wheaton C. (17-3200-700)	4	2.6	Occasionally confined. Lower gradient.	4	(Ø)	Low -10% pools -shallow	Moderate -high side channels	-Probably no fish present. -Appears to lack overwintering habitat.
Greenrock C. (17-3200-810)	1	0.4	Fan area. Fairly steep gradient. Shallow, with swift flow.	10	(SP)	Low -10% pools -swift flow	Low -low side channels -swift flow	-This reach may be utilized by species from Turnagain River.
	2	1.3	Bedrock canyon area with steep gradient and falls.	5	(Ø)	Low -20% pools -very steep gradient	Low -steep gradient canyon	-Probably no fish present above falls.
	3	3.6	Occasional confinement. Moderate gradient. Uniform swift flow throughout.	6	(Ø)	Low -5% pools	Low -low side channels	-Probably no fish present. -Lacks overwintering habitat.
	4	4.6	Frequent confinement. Moderate gradient. Swift, broken flow.	4	(Ø)	Low -0% pools	Low -no side channels	-Probably no fish present.
Little Greenrock C (17-3200-830)	1	0.3	Fan area. Moderate gradient. Shallow, with swift flow.	8	(SP)	Low -10% pools -swift flow	Low -moderate side channels, but flow is very swift	-Species from Turnagain R. may utilize this reach.
	2	0.8	Entrenched canyon area. Very steep gradient with impassible falls.	4	(Ø)	Low -falls area	Low -falls area	-Probably no fish present above falls.
	3	4.1	Frequent confinement. Moderate gradient. Uniform swift flow.	4	(Ø)	Low -10% pools -swift flow	Low -no side channels	-Probably no fish present.
	4	3.3	Steep gradient. Swift flow.	2	(Ø)	Low -0% pools	Low -no side channel	-Probably no fish present.

TABLE A1 CONT'D.

Stream (Watershed Code)	Reach	Reach Length (km)	Description	Chan. Width (m)	Fish Species Present (or suspect)	Habitat Evaluations		Comments
						Adult Holding	Fry Rearing	
Tumble C. (17-3200-870)	1	0.2	Fan area. Shallow, with uniform swift flow.	5	(SP)	Low -10% pools -swift flow	Low -low side channels -swift flow	-Species from Turnagain R. may utilize this reach.
	2	0.7	Bedrock canyon area. Steep gradient with impassable falls.	4	(Ø)	Low -falls area	Low -falls area	-Probably no fish present above falls.
	3	1.5	Frequent confinement. Lower gradient. Some beaver dams.	4	(Ø)	Moderate -lower gradient -some beaver ponds	Moderate -lower gradient -some shallow rearing areas	-Suspect no fish present, although habitat appears suitable.
	4	3.2	Occasional confinement. Uniform swift flow.	2	(Ø)	Low -10% pools	Low -low side channels	-Some beaver dams present.
Snowdrift C. (17-3200-930)	1	1.4	Fan area. Shallow. Uniform depth and swift flow. Moderate gradient (approx. 1.5%)	25	SP (GR, DV, MW, RB)	Low -0% pools -high velocity (1.7 m/sec.)	Moderate -some side channels, undercut banks, and debris	-Possibly some suitable spawning areas - 30% gravels.
	2	4.3	Entrenched, high gradient, with a bedrock canyon and falls.	12	(DV, RB)	Low -a few large pools in canyon	Low -no side/back channels -high velocity	-May be some overwintering in canyon pools.
	3	4.7	Frequently confined. Shallow. Uniform depth and swift flow.	30	(DV, RB)	Low -10% pools -high velocity	Low -few side/back channels -high velocity	
	4	0.9	Broad valley. Occasional confinement. Lower gradient (approx. 1%). Shallow.	20	DV, (RB)	Moderate -40% pools, but pools generally shallow (<1 m).	Moderate -high side/back channels -some undercut banks	-May be some overwintering, but pools are mostly shallow.

TABLE A1 CONT'D.

Stream (Watershed Code)	Reach	Reach Length (km)	Description	Chan. Width (m)	Fish Species Present (or suspect)	Habitat Evaluations		Comments
						Adult Holding	Fry Rearing	
Snowdrift C. (17-3200-930)	5	5.3	Frequently confined. Shallow. Uniform depth and swift flow.	12	(DV, RB)	Low -0% pools	Low -few side/back channels	
	6	4.9	Confined. Shallow. Uniform depth and swift flow.	9	(DV, RB)	Low -0% pools	Low -no side/back channels	
	7	5.7	Broad valley. Low gradient (<1%). Placid, lake-like sections connected by riffles	20	DV, RB	High -most of reach is broad, shallow, pools	High -low velocity -some side/back channels -good riffle sections between pools	-Large adult DV and RB indicate this area is utilized for overwintering. -Some good spawning areas in riffles.
	8	5.7	Broad valley. Channel unconfined. Shallow.	12	(DV, RB)	Low -0% pools -very shallow	Moderate -some side/back channels	
Cariboo C. (17-3200-930-070)	1	12.9	Broad valley. Occasional confinement. Lower gradient (approx. 1%). Meandering.	10	DV, (RB)	Moderate -good holding in lower part of reach	Moderate -high side/back channels, especially in lower part of reach	-Spawning gravel available in several areas - 60% gravels. -some old beaver dams present.
	2	4.6	Broad valley. Channel unconfined. Low gradient (<1%). Meandering.	25	DV	Moderate -30% pools -Moderate velocity (0.5 m/sec)	High -high side/back channels - low gradient	-Adult DV present - may be some overwintering.
Unnamed C. (17-3200-930-120)	1	2.4	Broad valley. Channel unconfined. Lower gradient (approx. 1%). Mostly shallow riffle.	15	(DV, RB)	Low -0% pools -may be some holding in placid section near mouth	Moderate -some side/back channels - considerable shallow riffle area.	

TABLE A1 CONT'D.

Stream (Watershed Code)	Reach	Reach Length (km)	Description	Chan. Width (m)	Fish Species Present (or suspect)	Habitat Evaluations		Comments
						Adult Holding	Fry Rearing	
Unnamed C. (17-3200-930-120)	2	1.4	Broad valley. Channel unconfined. Meandering.	6	(DV)	Moderate -30% pools	Moderate -high side/back channels	
	3	3.1	Frequently confined. High elevation headwater area.	6	(DV)	Low -0% pools	Low -few side/back channels -high velocity	
Settea C. (17-3200-950)	1	0.2	Fan area. Unconfined channel. Low gradient.	30	DV, GR, (SP)	Moderate -0% pools, but low velocity and suitable depth	Moderate -no side channels, but very low velocity and some shallow areas.	-Lacks cover for both adult holding and rearing. -Other species from Turnagain R. may utilize this reach (i.e., MW, RB, LT)
	2	1.9	Occasional confinement. Approx. 1% gradient. Moderate velocity.	30	DV, GR	Moderate -10% pools, but moderate velocity and suitable depth	Moderate -low side channels, but good shallow riffle areas	-40% gravels - appear to be some suitable spawning areas.
	3	8.7	Entrenched channel. Moderate gradient. Swift flow.	15	DV	Low -10% pools -swift flow	Low -low side channels -swift flow	
	4	6.3	Broad valley. Low gradient (<1%).	10	DV	Moderate -10% pools, but low velocity and suitable depth	Moderate -low side channels, but many suitable back channel areas.	
	5	0.9	Unconfined channel. Low gradient with placid sections.	5	DV	Moderate -10% pools, but low velocity and suitable depth	Moderate -low side channels, but good back channels and shallow, low velocity areas	-DV may overwinter in nearby Settea Lake.

TABLE A1 CONT'D.

Stream (Watershed Code)	Reach	Reach Length (km)	Description	Chan. Width (m)	Fish Species Present (or suspect)	Habitat Evaluations		Comments
						Adult Holding	Fry Rearing	
Settea C. (17-3200-950)	6	1.3	Settea Lake		DV			
	7-9	0.9	Headwater Area.		DV	——	——	-Lacks habitat information
Eagle R. (18-6300)	101	1.9	Wide, shallow, swift flowing. Uniform depth and flow conditions.	70	(GR, DV)	Low -10% pools -high velocity	Low -few side/back channels -main channel very swift	
	102	10.5	Channel mostly wide and shallow. Some confined areas. Swift flowing.	35	GR	Low -10% pools -high velocity (>1 m/sec.)	Low -few side/back channels - main channel very swift	
	103	10.6	Wide, shallow, swift flowing. Uniform depth and flow conditions.	40	(GR)	Low -0% pools	Low -few side/back channels -main channel very swift	
	104	9.1	Wide, shallow, swift flowing. Uniform depth and flow conditions.	30	GR	Low -10% pools -high velocity (>1 m/sec.)	Low -some side/back channels, but mainly very swift	-Possibly some spawning gravel available - 70% gravels.
	105	2.7	Mostly wide and shallow. Slightly lower gradient.	20	(GR)	Low -10% pools -moderate velocity and shallow	Moderate -some side/back channels and shallow riffle areas	
	106	6.1	Wide and shallow. Occasional confinement. Lower gradient.	10	GR, LT, (MW, LSu)	Low -10% pools -moderate velocity and shallow	High -high side/back channels and shallow riffle areas	-some good gravel areas for spawning just below Eagle-head Lake. -Adults probably overwinter in the lake.

TABLE A1 CONT'D.

Stream (Watershed Code)	Reach	Reach Length (km)	Description	Chan. Width (m)	Fish Species Present (or suspect)	Habitat Evaluations		Comments
						Adult Holding	Fry Rearing	
Eagle R. (18-6300)	107	6.4	Eaglehead Lake		GR, LT, MW, LSu			
	108	3.2	Channel unconfined. Low gradient (<1%). Meandering.	12	GR, (LT, MW, LSU)	Moderate -20% pools -low velocity (<0.5 m/sec.)	High -high side/back channels -low gradient -some undercut banks	-Some good gravel areas for spawning. -Adults probably overwinter in Eaglehead Lake.
	109	1.1	Higher gradient (>1%). Shallow. Uniform depth and swift flow.	6	(GR, MW)	Low -0% pools	Low -no side/back channels -high velocity	
	110	0.8	Occasionally confined. Lower gradient.	8	(GR, MW)	Low -20% pools -moderate velocity and shallow	Moderate -some side/back channels -moderate velocity	
	111	2.1	Very high gradient bedrock canyon area with impassible falls.	6	(Ø)	Low -10% pools -very steep gradient	Low -very steep gradient	-Probably no fish present above falls due to lack of overwintering areas.
	112	2.1	Headwater area. Moderate gradient (1-2%).	7	(Ø)	Low -10% pools -moderate velocity (0.5-1.0 m/sec.)	Low -low side/back channels -moderate velocity	-Probably no fish present due to lack of overwintering areas.
	113	3.7	Headwater area. Low gradient (<1%). Meandering.	5	(Ø)	Moderate -20% pools -low velocity (<0.5 m/sec.)	Moderate -moderate side/back channels -low gradient	-Probably no fish present due to lack of overwintering areas.

TABLE A1 CONT'D.

Stream (Watershed Code)	Reach	Reach Length (km)	Description	Chan. Width (m)	Fish Species Present (or suspect)	Habitat Evaluations		Comments
						Adult Holding	Fry Rearing	
Little Eagle R. (18-6300-560)	1	16.6	Mostly shallow and swift flowing. Little variation in depth or flow.	20	(GR, DV)	Low -10% pools -high velocity (>1 m/sec.)	Moderate -high side/back channels -some undercut banks	-The lower portion of the reach is lower gradient and has the most holding and rearing habitat.
	2	10.6	Frequently confined. Mostly shallow and swift flowing.	12	(GR)	Low -10% pools -high velocity	Low -low side/back channels -high velocity	
	3	7.7	Occasionally confined. Lower gradient (approx. 1%). Meandering.	9	(GR)	Moderate -30% pools -moderate velocity (0.5-1.0 m/sec.)	Moderate -high side/back channels -moderate velocity	
	4	8.1	Occasionally confined. Some flooded wetland areas. Irregular meandering.	5	(GR)	Moderate -40% pools, but pools are shallow.	Moderate -moderate side/back channels some quiet, ponded areas	
	5	2.4	Steep gradient canyon area with falls.	3	?	Low -steep gradient	Low -steep gradient	
	6	0.7	Frequently confined. Moderate gradient.	5	?	Low -10% pools -swift flow	Low -low side/back channels -swift flow	
Unnamed C. (18-6300-560-080) (Moose Lakes C.)	1	6.5			(SP)			-Not Surveyed.
	2	2.7	Moose Lakes		DV, GR, LT, MW, LKC, LSu			

TABLE A1 CONT'D.

Stream (Watershed Code)	Reach	Reach Length (km)	Description	Chan. Width (m)	Fish Species Present (or suspect)	Habitat Evaluations		Comments
						Adult Holding	Fry Rearing	
Swinton C. (18-6300-560-120)	1	2.9			(SP)			-Not Surveyed.
	2	2.1	Swinton Lake.		GR, LT, MW, LKC, LSu			
Unnamed C. (18-6300-560-140) (Fish Lake C.)	1	0.7	Steep gradient bedrock canyon area with falls.	5	(GR, SP)	Low -steep gradient	Low -steep gradient	-A short, low-gradient section near the mouth may provide some rearing habitats.
	2	3.2	Fish Lake.		GR			
Goldpan C. (18-6300-560-240)	1	0.7	Fan area. Shallow and swift flowing.	20	?	Low -0% pools -swift flow	Low -no side/back channels -swift flow	
	2	1.7	Entrenched, steep gradient area.	11	?	Low -10% pools -swift flow	Low -no side/back channels -swift flow	
	3	2.5	Confined channel. Shallows and swift flowing. High gradient.	8	?	Low -0% pools -swift flow	Low -no side/back channels -swift flow	-There is placer mining activity in this reach.
Unnamed C. (18-6300-640)	1	6.1	Occasionally confined. Mostly shallow. Moderate velocity.	10	GR	Moderate -20% pools -moderate velocity	Moderate -moderate side/back channels -some undercut banks	-Adult GR present at time of survey.
Unnamed C. (18-6300-720)	1	1.9	Mostly shallow and swift flowing.	8	(GR)	Low -10% pools -high velocity	Low -some side/back channels, but high velocity	

TABLE A1 CONT'D.

Stream (Watershed Code)	Reach	Reach Length (km)	Description	Chan. Width (m)	Fish Species Present (or suspect)	Habitat Evaluations		Comments
						Adult Holding	Fry Rearing	
Unnamed C. (18-6300-720)	2	12.8	Frequently confined. Moderate gradient.	5	?	Low -10% pools -moderate velocity	Low -some side/back channels -moderate gradient	
	3	0.7	Entrenched canyon area. Steep gradient with falls.	4	?	Low -steep gradient	Low -steep gradient	
Unnamed C. (18-6300-750)	1	6.4	Shallow and swift flowing.	7	(GR, MW)	Low -0% pools	Low -low side/back channels	
	2	1.3	Shallow and swift flowing.	5	(GR, MW)	Low -2% pools -swift flow	Low -no side/back channels	
	3	1.8	Channel unconfined. Low gradient. Meandering.	10	(GR, MW, LT)	High -40% pools -low velocity	High -high side/back channels -low velocity	-Adults may overwinter in nearby lakes.
	4	2.1	Lake.		(GR, MW, LT)			
	5	1.0	A series of placid sections connected by riffle areas.	14	(GR, MW, LT)	Moderate -good holding in the placid sections	Moderate -low velocity in pools -some shallow riffle areas	-Nearby lakes are probably used for overwintering. -Riffle areas may be used for spawning.
	6	5.5	Serpentine Lake.		GR, MW, LT			
	7	3.3	Low gradient. Meandering.	9	(GR, MW, LT)	High -40% pools -moderate velocity (0.5-1.0	Moderate -moderate side/back channels -low gradient	-Probably an important spawning and rearing area for Serpentine Lake - 70% gravels.

TABLE A1 CONT'D.

Stream (Watershed Code)	Reach	Reach Length (km)	Description	Chan. Width (m)	Fish Species Present (or suspect)	Habitat Evaluations		Comments
						Adult Holding	Fry Rearing	
Unnamed C. (18-6300-840)	1	2.3	Low gradient. Meandering.	5	(GR, MW, LT, LSu)	High -40% pools -low gradient	Moderate -moderate side/back channels -low gradient	-Good spawning areas available -50% gravels.
Zuback C.	1		Mostly shallow and swift flowing.	13	(DV)	Low -0% pools -high velocity	Low -no side/back channels	
	2		Mostly shallow and swift flowing. Irregular meanders.	10	DV	Low -10% pools -high velocity (>1 m/sec.)	Moderate -high side/back channels	
	3		Steep gradient. Bedrock canyon area with impassible falls.	15	(Ø)	Low -very steep gradient	Low -very steep gradient	
	4		Shallow, swift flowing multiple-channel area.	25	?	Low -10% pools -shallow with swift flow	Moderate -high side channels -large amount of shallow riffle	-May be no fish present due to lack of overwintering habitat.
	5		Shallow and swift flowing.	15	?	Low -10% pools -swift flow	Low -low side/back channels	-May be no fish present due to lack of overwintering habitat.
	6		Steep gradient, canyon area.	7	(Ø)	Low -steep gradient	Low -steep gradient	
Unnamed C. (Trib. to Zuback C.)	1		Steep gradient, canyon area.	10	?	Low -steep gradient -40% pools	Low -steep gradient	-May be some holding in canyon pools.
	2		Shallow braided area.	90	?	Low -0% pools	Moderate -high side channels	-May be no fish present due to lack of overwintering areas.

TABLE A1 CONT'D.

Stream (Watershed Code)	Reach	Reach Length (km)	Description	Chan. Width (m)	Fish Species Present (or suspect)	Habitat Evaluations		Comments
						Adult Holding	Fry Rearing	
Unnamed C. (Trib. to Zuback C.)	3		Steep gradient, bedrock canyon area with impassible falls.	12	(Ø)	Low -steep gradient	Low -steep gradient	-Probably no fish present.
	4		Occasionally confined. Lower gradient.	15	(Ø)	Moderate -30% pools -moderate velocity	Moderate -high side/back channels	-Probably no fish present due to lack of overwintering.
	5		Very wide, shallow riffle area.	40	(Ø)	Low -10% pools -very shallow	Low -no side channels -swift flow.	-Probably no fish present due to lack of overwintering.
	6		Shallow, swift flowing.	8	(Ø)	Low -0% pools	Moderate -high side/back channels	-Probably no fish present due to lack of overwintering.

APPENDIX 2

INDIVIDUAL FISH DATA - RAINBOW LAKE (SOUTH)

LAKE SURVEYS - FISH DATA SHEET

LEGEND:

1. MATURITY: IMM - Immature; MG - Maturing; MT - Mature; R - Ripe; SP - Spent; ? - Not Known
2. SAMPLE TYPE: TG - Fish Tag; OT - Otolith; SC - Scale
3. SEX: M - Male; F - Female; ? - Not Known

LOCALITY: Rainbow Lakes (south)

DATE: July 27, 1980

METHOD OF CAPTURE: Monofilament Gill Net

SPECIES	FORK LENGTH (cm)	WEIGHT (gm)	SEX	MATURITY	SAMPLE TYPE	AGE	STOMACH CONTENTS: BOTTOM ORGANISMS	STOMACH CONTENTS: PLANKTON	STOMACH CONTENTS: TERRESTRIAL INSECTS	STOMACH CONTENTS: FISH	TOTAL VOLUME	COMMENTS
Rainbow Trout	10.7	15	F	IMM	SC	1+						
"	13.2	25	M	IMM	SC	1+						
"	14.1	30	F	IMM	SC	2+						
"	18.2	70	F	MG	SC	3+						
"	18.9	80	F	MG	SC	3+						
"	21.1	85	M	IMM	SC	-						
"	24.0	150	F	MG	SC	5+						
"	24.1	165	M	IMM	SC	3+						
"	25.5	180	F	MG	SC	3+						
"	26.3	220	F	MG	SC	4+						
"	27.0	215	M	IMM	SC	4+						
"	27.3	230	F	MG	SC	5+						Fish lice all over
"	27.6	225	M	IMM	SC	5+						
"	29.3	300	M	IMM	SC	4+						Fish lice
"	29.5	275	F	MG	SC	5+						
"	29.6	300	F	MG	SC	5+						
"	30.0	325	F	MG	SC	5+						Fish lice, orange worms in stomach.
"	31.5	350	M	IMM	SC	5+						
"	33.0	450	M	IMM	SC	6+						
"	33.6	425	M	IMM	SC	6+						
"	33.7	375	F	MG	SC	5+						
"	34.3	425	F	MG	SC	7+						
"	34.8	475	F	MG	SC	5+						
"	35.0	475	F	MG	SC	6+						
"	35.3	525	M	MG	SC	6+						
"	35.5	500	M	MG	SC	5+						Fish lice
"	35.5	550	M	MT	SC	-						
"	37.0	600	M	MG	SC	6+						
"	37.1	575	F	MG	SC	7+						Fish lice on cauda fin. Tape worms in body cavity.
												Little orange worm

LAKE SURVEYS - FISH DATA SHEET

LOCALITY Rainbow Lakes (south)

DATE July 27, 1980

METHOD OF CAPTURE Monofilament Gill Net

LEGEND:

1. MATURITY: IMM - Immature; MG - Maturing; MT - Mature; R - Ripe; SP - Spent; ? - Not Known
2. SAMPLE TYPE: TG - Fish Tag; OT - Otolith; SC - Scale
3. SEX: M - Male; F - Female; ? - Not Known

SPECIES	FORK LENGTH (cm)	WEIGHT (gm)	SEX	MATURITY	SAMPLE TYPE	AGE	STOMACH CONTENTS				TOTAL VOLUME	COMMENTS
							BOTTOM ORGANISMS	PLANKTON	TERRESTRIAL INSECTS	FISH		
Rainbow Trout	40.0	700	F	MG	SC	6+						
"	40.0	750	F	MG	SC	7+						
"	40.2	725	F	MG	SC	6+						
"	40.4	750	F	MG	SC	7+						
"	40.7	675	M	MG	SC	6+						
"	40.8	750	M	MG	SC	6+						Fish lice. Litt
"	40.8	800	F	MG	SC	8+						orange worms.
"	41.2	700	F	MG	SC	7+						
"	41.7	675	F	MG	SC	7+						
"	42.1	800	M	MG	SC	7+						
"	42.4	850	F	MG	SC	9+						Little orange worms.
"	42.8	900	F	MG	SC	7+						
"	42.9	900	M	MG	SC	7+						
"	43.0	950	M	MG	SC	7+						
"	43.1	900	F	MG	SC	9+						Fish Lice
"	44.1	925	F	MG	SC	8+						
"	45.0	925	F	SP	SC	9+						
"	46.7	1100	F	AP	SC	8+						
"	49.9	1425	M	MG	SC	9+						
Dolly Varden	23.5	120	M	IMM	OT	6+						Fish Lice
"	24.7	150	F	MG	OT	7+						
"	25.0	135	M	IMM	OT	5+						
"	25.2	150	F	IMM	OT	5+						
"	27.0	195	M	IMM	OT	6+						
"	27.2	185	M	IMM	OT	6+						
"	28.0	200	F	IMM	OT	-						
"	30.1	240	F	MG	OT	7+						worms in body cavity
"	31.0	300	M	IMM	OT	7+						
"	21.2	85	M	IMM	OT	5+						

LAKE SURVEYS - FISH DATA SHEET

LEGEND:

1. MATURITY: IMM - Immature; MG - Maturing; MT - Mature; R - Ripe; SP - Spent; ? - Not Known
2. SAMPLE TYPE: TG - Fish Tag; OT - Otolith; SC - Scale
3. SEX: M - Male; F - Female; ? - Not Known

LOCALITY Rainbow Lakes (south)

DATE July 27, 1980

METHOD OF CAPTURE Monofilament Gill Net

SPECIES	FORK LENGTH (cm)	WEIGHT (gm)	SEX	MATURITY	SAMPLE TYPE	AGE	STOMACH CONTENTS				TOTAL VOLUME	COMMENTS
							BOTTOM ORGANISMS	PLANKTON	TERRESTRIAL INSECTS	FISH		
Dolly Varden	31.4	275	M	IMM	OT	8+						Tapeworms in body cavity
"	32.5	300	F	MG	OT	9+						Little orange worms in gut.
"	41.5	675	M	IMM	OT	10+					Empty	Gonads small and narrow.
"	52.5	1475	F	MT	OT	12+						
Mountain Whitefish	13.1	25	M	IMM	SC	2+						
"	13.2	20	?	IMM	SC	2+						
"	13.2	25	F	IMM	SC	2+						
"	13.8	30	F	IMM	SC	2+						
"	14.0	30	M	IMM	SC	2+						
"	21.3	110	F	IMM	SC	3+						
"	23.2	150	F	IMM	SC	4+						
"	30.1	350	F	MG	SC	7+						
"	31.1	350	F	MG	SC	7+						
"	31.5	350	F	MG	SC	7+						
"	31.5	375	F	MG	SC	7+						
"	31.5	375	F	MG	SC	7+						
"	31.7	375	M	MG	SC	7+						
"	31.8	350	M	MG	SC	7+						
"	32.0	400	F	MG	SC	7+						
"	32.0	400	M	MG	SC	7+						
"	32.1	400	M	MG	SC	8+						
"	32.1	425	M	MG	SC	8+						
"	32.3	400	F	MG	SC	7+						
"	32.4	375	M	MG	SC	8+						
"	32.5	450	F	MG	SC	8+						
"	32.6	400	F	MG	SC	8+						

LAKE SURVEYS - FISH DATA SHEET

LEGEND:

1. MATURITY: IMM - Immature, MG - Maturing, MT - Mature, R - Ripe, SP - Spent, ? - Not Known
2. SAMPLE TYPE: TC - Fish Tag, OT - Otolith, SC - Scale
3. SEX: M - Male, F - Female, ? - Not Known

LOCALITY Rainbow Lakes (south)

DATE July 27, 1980

METHOD OF CAPTURE Monofilament Gill Net

SPECIES	FORK LENGTH (cm)	WEIGHT (gm)	SEX	MATURITY	SAMPLE TYPE	AGE	STOMACH CONTENTS				TOTAL VOLUME	COMMENTS
							BOTTOM ORGANISMS	PLANKTON	TERRESTRIAL INSECTS	FISH		
Mountain Whitefish	32.7	350	F	MG	SC	8+						
"	33.1	400	F	MG	SC	8+						
"	33.5	425	F	MG	SC	8+						
"	33.7	450	M	MT	SC	8+						
"	33.7	500	F	MG	SC	8+						
"	34.0	450	F	MG	SC	8+						
"	34.2	400	F	MG	SC	8+						
"	34.2	425	M	MG	SC	9+						close to mature
"	34.2	450	M	MG	SC	10+						V. close to mature
"	34.3	400	F	MG	SC	9+						
"	35.0	450	F	MG	SC	9+						
"	35.0	500	F	MG	SC	-						
"	35.2	475	F	MG	SC	-						
"	35.3	500	F	MG	SC	8+						
"	35.6	475	F	MG	SC	8+						
"	36.2	550	F	MG	SC	8+						
"	37.0	525	F	MG	SC	9+						
"	37.1	575	F	MG	SC	9+						
"	37.3	625	M	MT	SC	9+						
"	37.5	600	M	MG	SC	10+						
"	37.7	600	F	MG	SC	10+						
"	37.8	575	M	MG	SC	10+						
"	37.8	600	F	MG	SC	11+						
"	38.0	625	F	MG	SC	10+						
"	38.4	700	M	MT	SC	12+						
"	38.8	750	F	MT	SC	9+						
"	39.0	675	F	MG	SC	12+						
"	40.9	700	F	MG	SC	12+						

APPENDIX 3

LONG-TERM NORMALS FOR THE DEASE LAKE CLIMATOLOGICAL STATION

A. Precipitation	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Year
Mean total precipitation (mm)	28.2	25.9	21.2	11.7	21.3	38.4	53.8	54.1	43.7	34.0	32.0	30.2	394.4
Mean rainfall (mm)	0.8	0.3	0.5	1.3	16.8	37.6	52.8	54.1	42.9	15.7	3.0	0.5	226.3
Mean snowfall (cm)	29.5	29.2	22.9	11.7	4.6	0.8	1.3	T	0.8	18.8	34.3	33.0	186.9
Greatest rainfall in 24 hours (mm)	11.7	2.5	11.2	7.4	20.1	27.9	39.9	45.7	23.1	21.3	8.6	5.6	45.7
Greatest snowfall in 24 hours (cm)	23.4	25.7	26.2	15.5	15.2	6.4	28.7	1.8	3.6	28.2	25.9	21.8	28.7
Greatest precipitation in 24 hours (mm)	19.6	23.9	24.4	11.9	20.1	27.9	59.2	45.7	23.1	28.2	22.9	22.6	59.2
Number of days with measurable precipitation	13	12	9	8	9	12	13	14	15	12	13	13	143
B. Temperature													
Mean daily temperature (°C)	-19.3	-13.2	-7.2	-0.1	6.4	10.8	12.6	11.4	7.4	1.3	-8.3	-15.6	-1.2
Mean daily maximum temperature (°C)	-14.7	-7.6	-0.4	5.9	13.4	18.0	19.4	18.2	13.3	5.9	-4.1	-11.3	4.7
Mean daily minimum temperature (°C)	-24.1	-18.9	-13.9	-6.2	-0.7	3.5	5.8	4.7	1.4	-3.3	-12.5	-20.0	-7.2
Extreme maximum temperature (°C)	8.9	11.7	12.8	18.9	31.7	33.9	31.7	31.1	28.9	20.6	14.4	7.2	33.9
Extreme minimum temperature (°C)	-51.1	-48.3	-47.8	-31.7	-11.1	-5.6	-2.2	-6.1	-15.0	-23.3	-38.9	-46.1	-51.1

Source: Environment Canada, 1973. Canadian Normals. Vol. 1 - Temperature and Vol. 2 - Precipitation. Atmospheric Environment Service

MAPS NOT

FILMED

CARTES

OMISES